OCTOBER, 1969

Railway Signaling & Communications

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When you buy cable you're buying something that's not made yet.

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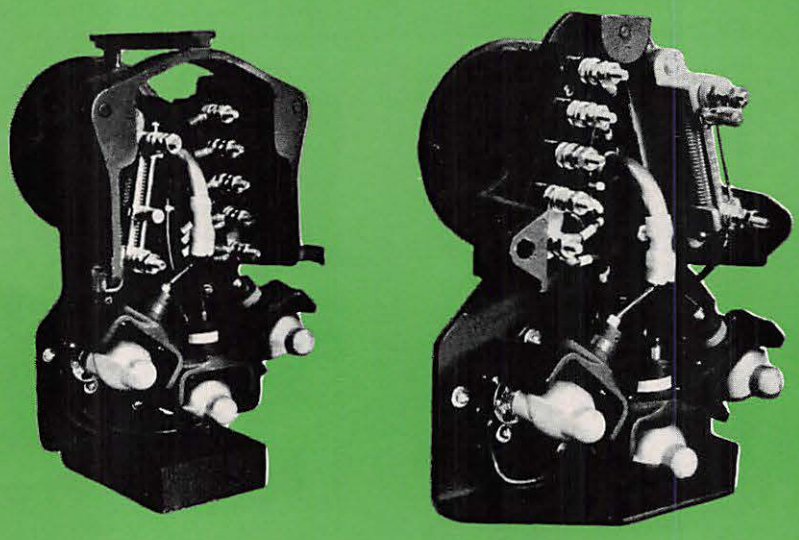
CONVERSION UNITS for existing SEARCHLIGHT SIGNALS



- to provide all color indications through one lens **DEPENDABLY!**
- to fit existing housings **PERFECTLY!**

available as replacements for all current mechanism assemblies with either stepped or compound lenses.

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IN CANADA: Vale Enterprises, Ltd., 1120 Claire Crescent, Lachine, Quebec
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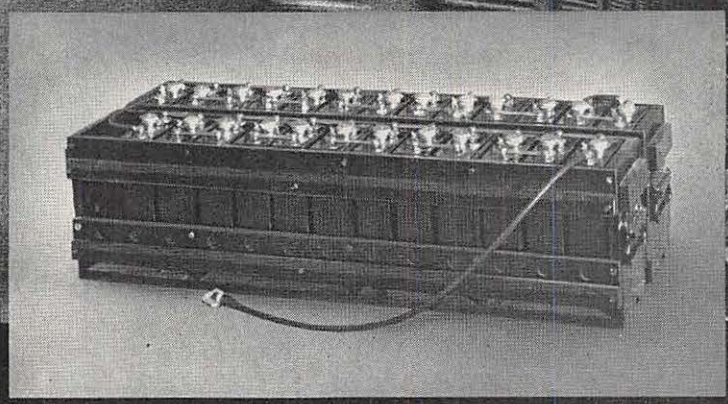
Circle 1 on reader service card

The battery and ½



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So you won't have to baby them when they get older like all those other batteries.

The Exide nickel-iron battery lives so long because it's made of steel. Not just its case, but all the internal parts. Like the perforated tubes in the positive plate that now hold an improved combination of nickel flake and nickel hydrate. And the continuous strip negative plate that's made larger to meet the demands of this new active material. And both steel plates are actually preserved by the electrolyte solution.

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So when it comes to powering signals, control circuits for rapid transit cars, and communication systems, is it any wonder we call it a "battery and ½"? To learn more, write: Industrial Group, ESB Incorporated, Box 5723, Philadelphia, Pa. 19120.

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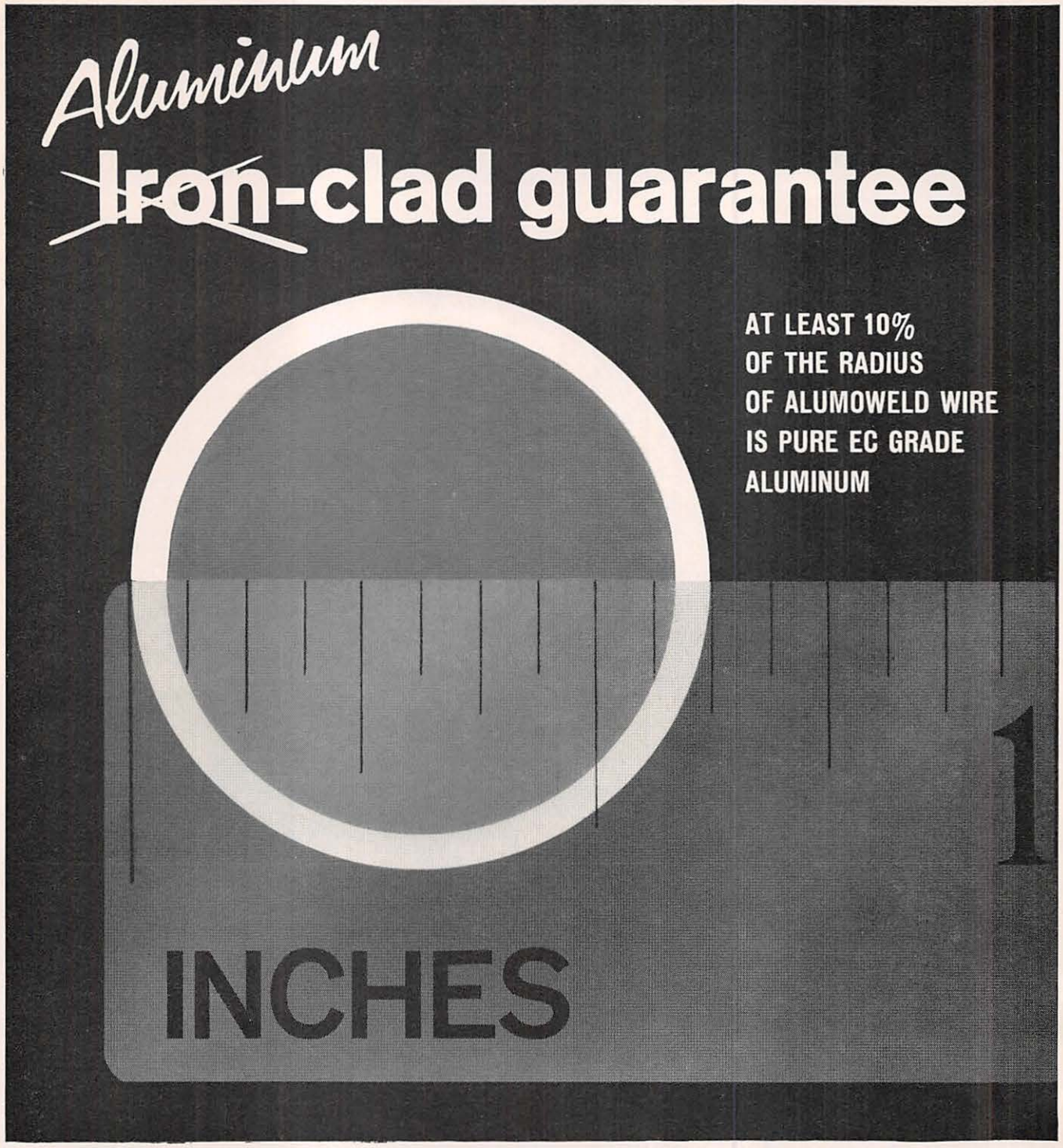

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and
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Every foot of Alumoweld wire is electronically checked for cladding continuity. Then we test it for tensile strength, elongation, diameter, and conductivity.

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SPECIALTY MATERIALS

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Editor's Corner

Impressions of the Communication & Signal Section, AAR, convention are many and varied.

—Three fine technical papers on microwave, but were really too detailed to be fully understood and appreciated when delivered at the meeting. For such papers, print them in advance and distribute to members when registering or earlier. Then speakers briefly comment and time is left for meaningful discussion.

—Equipment on exhibit is mostly transistorized including integrated circuits. Communications equipment outnumbered signal equipment on display.

—Former engineer of signals Eric Stephenson, now CN vice-president, jolted some with his plea for broadening C&S horizon. Even suggested C&S become systems engineers or cybernetics department. How about control systems?

—Preponderance of papers are from manufacturers. Need for more active participation by communications and signal men. Maintenance of automatic yards, re-evaluation of CTC system applications, as well as planning for ACI and AAR's TRAIN should have interest. And railroad men can speak from experience on these subjects.

—Good work by committees in weeding out obsolete material from the Signal and Communication Manuals. Keep it up, there's lots more dead wood still left.

—Good work by new Secretary Peter D. Bonin, and Engineer John McNabb for the improved format of the advanced reports. Much easier to read. Logotype with color-light signal, microwave tower and electricity shows ingenuity and initiative. They have gotten the Section on the way to an improved image already.

—Good work by committees in updating manuals. For example, B came up with performance requirements on microwave systems. Also some very fine information reports this year. For instance, C has a fine one on error control.

In summary, a good technical meeting. Still, I would like to see some management involvement in communication and signal meetings. For management, it is vital for them to have more understanding of communications and signals. However, as the technical experts or engineers, C&S men do have a responsibility to make their work understandable to management. With the rapidly changing technology, it's time for the managers and engineers to work towards a better understanding of each other's job. This relationship of the manager to the engineer, systems designer, computer expert or technician was discussed at the Data Systems Division meeting (see page 30).

Bob McKnight

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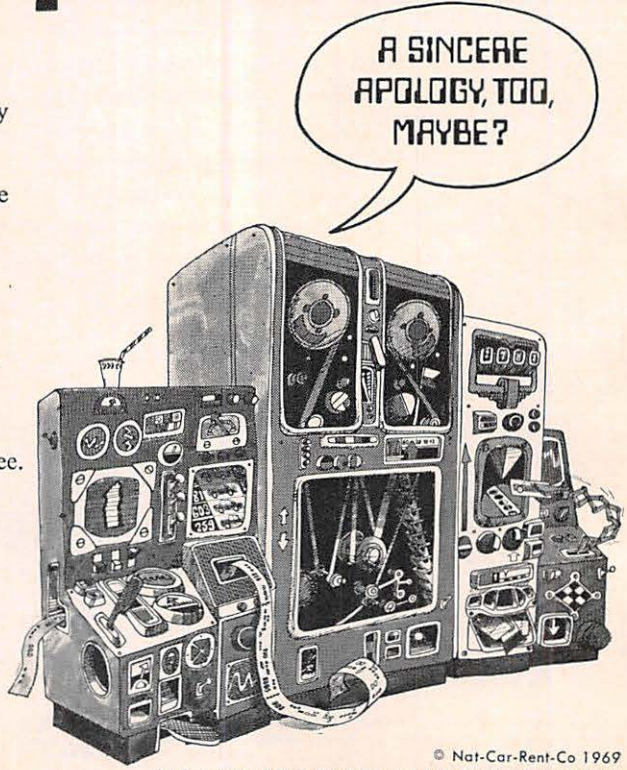

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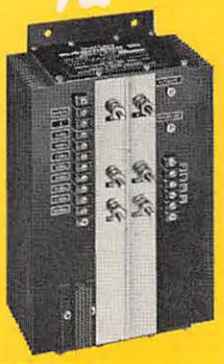

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For Charging: 5 to 12 cells of Nickel-Cadmium or Nickel-Iron
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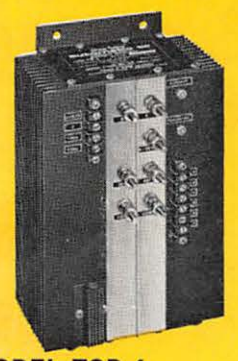

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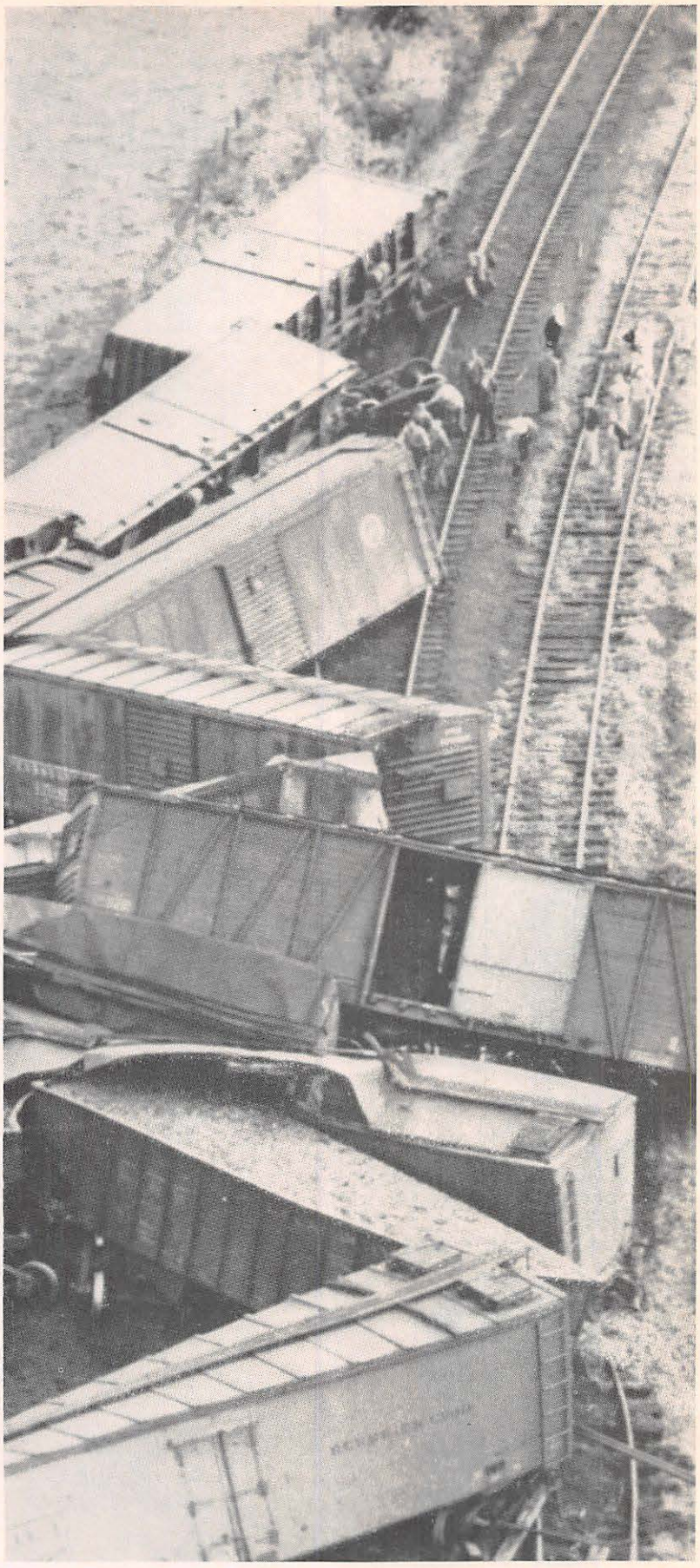

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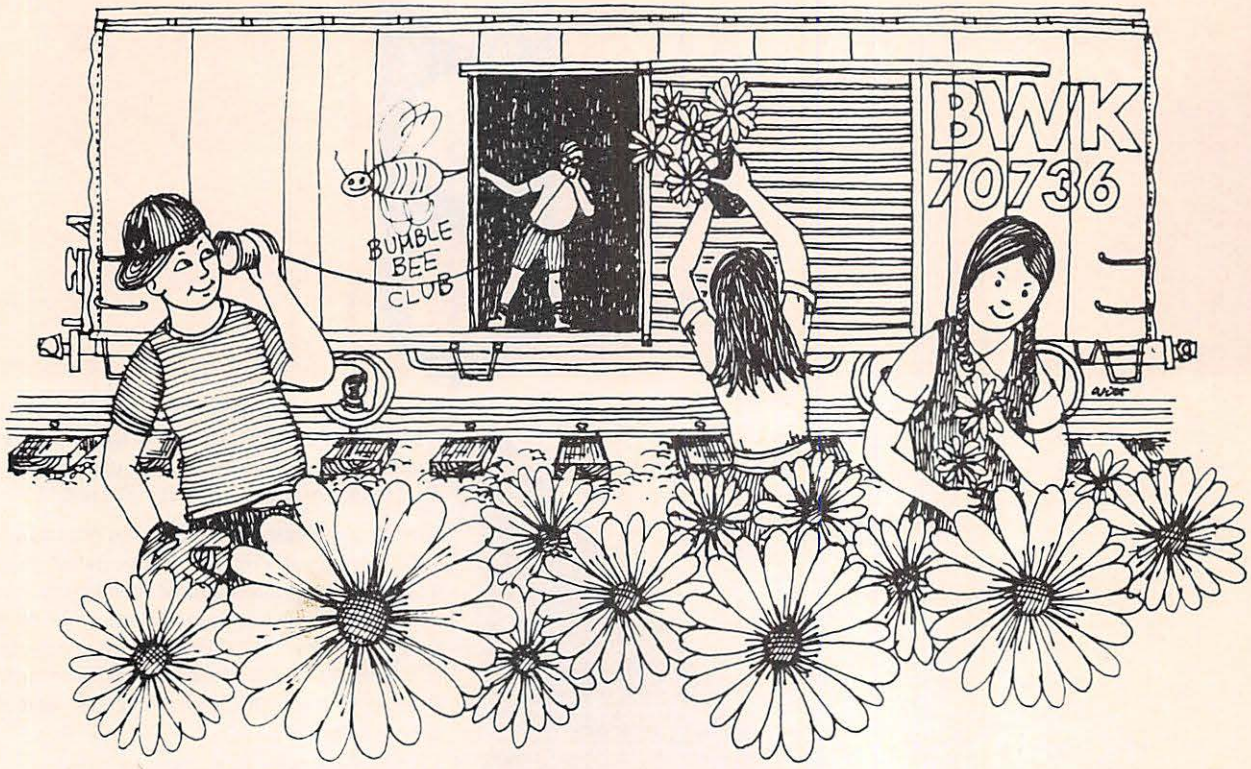

BWK70736
Where Are You?

On April 4, 1956, BWK70736, loaded with machine parts, left the big factory. This was the last day the railroad had any record of it.

Lost and abandoned, BWK was soon befriended by little Janice, Sally, Johnnie and Morty. It became the new clubhouse of the Bumble Bee Club.

That was a long time ago, but BWK is still happy with a new gang of kids who play along that unused stretch of track in Willow Springs.

There are many BWK's in our country. Car records are lost all the time for a variety of reasons. Tracing cars is but one of the railroad uses of Western Union Telex. Train consists, administrative messages and data gathering are some others. And by coupling Telex with a computer, you will benefit from today's most modern communications technology. Unless, of course, you don't mind donating cars as clubhouses.

western union

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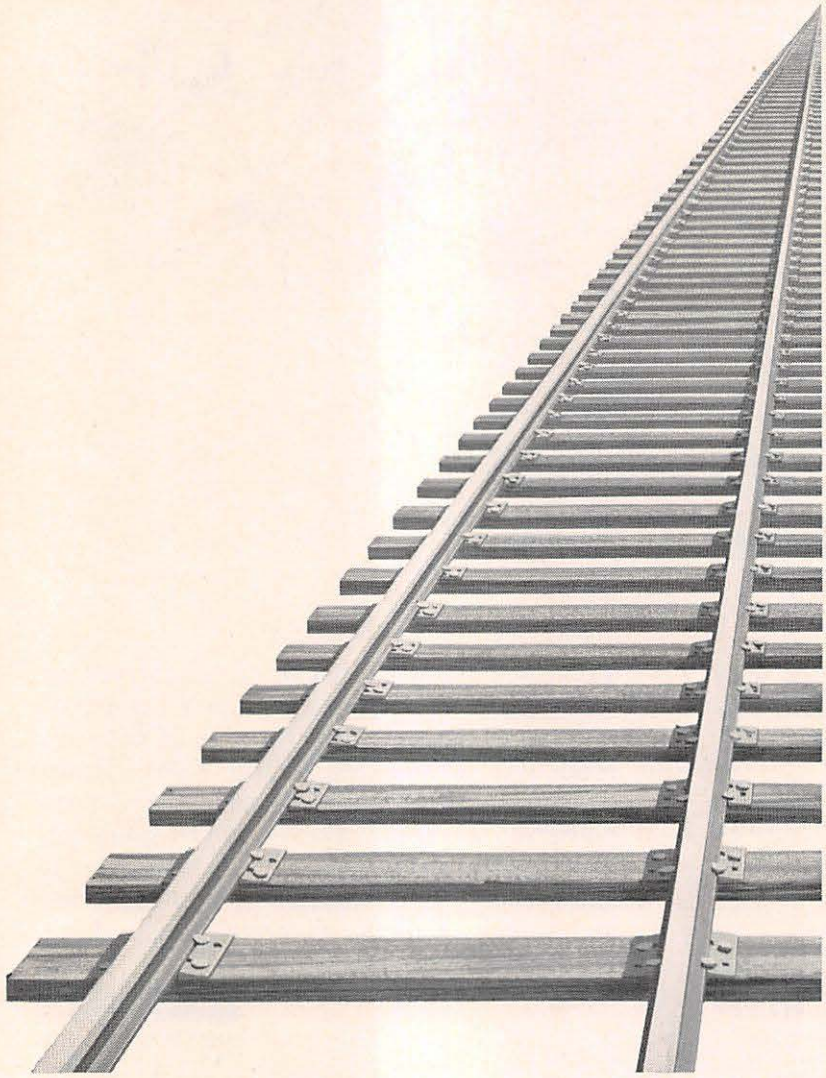
See any line wires?
Insulated joints?
Not with the PMC you don't!



Now proved in practice, the Marquardt Industrial Products' (MIPCO) Pulse Modulated Control has successfully demonstrated the use of solid state electronic equipment for signal control.

Specifically designed for reliable control of wayside signals, it eliminates insulated joints at intermediate signals, impedance bonds, electromechanical encoding apparatus, and line wires. In addition the MIPCO PMC systems are compatible with AC or DC electric propulsion currents, DC coded track, AC signal circuits, and coded cab signals.

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- Lower installation and maintenance costs; plug-in circuit modules
- Fail-safe operation under extreme environmental conditions
- Up to 11 carrier frequencies, each with up to 10 channels

CONTACT YOUR MIPCO REPRESENTATIVE TODAY.

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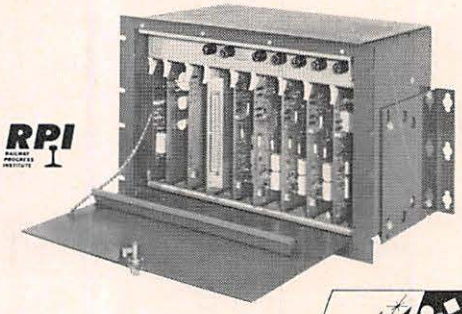

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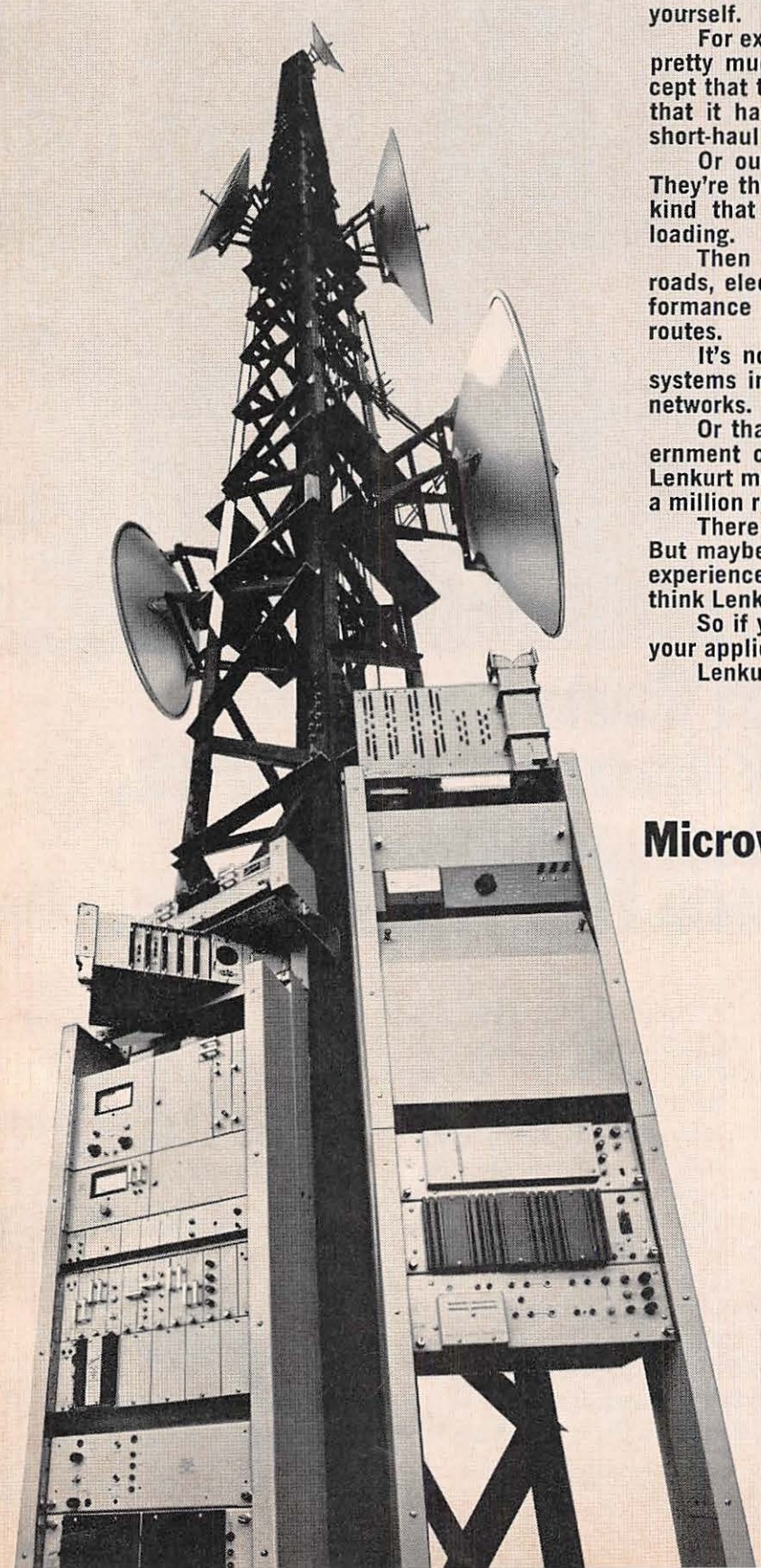


We could tell you that our microwave systems are the world's greatest. But you'd expect us to be partial.

So we'll just give you some facts and let you judge for yourself.

For example, our new 78A for the telephone industry. It's pretty much like everybody else's 960-channel system. Except that the linearity and delay characteristics are so good that it handles 25% more voice channels. That's 1200 on short-haul routes. It's the only baseband system that does.

Or our 75C and new 78J for government applications. They're the only heterodyne and baseband systems of their kind that can handle 600 DCS circuits with 100% data loading.

Then there's our 76 and 78 baseband systems for railroads, electric utilities, pipe lines, and TV. Their noise performance is so good they're even used for transcontinental routes.

It's no coincidence that you'll find Lenkurt microwave systems in AUTOVON, AUTODIN, INTELSAT, and COMSAT networks.

Or that more than 200 commercial, industrial, and government customers are operating more than 600 separate Lenkurt microwave systems in 40 countries. Over a quarter of a million route miles.

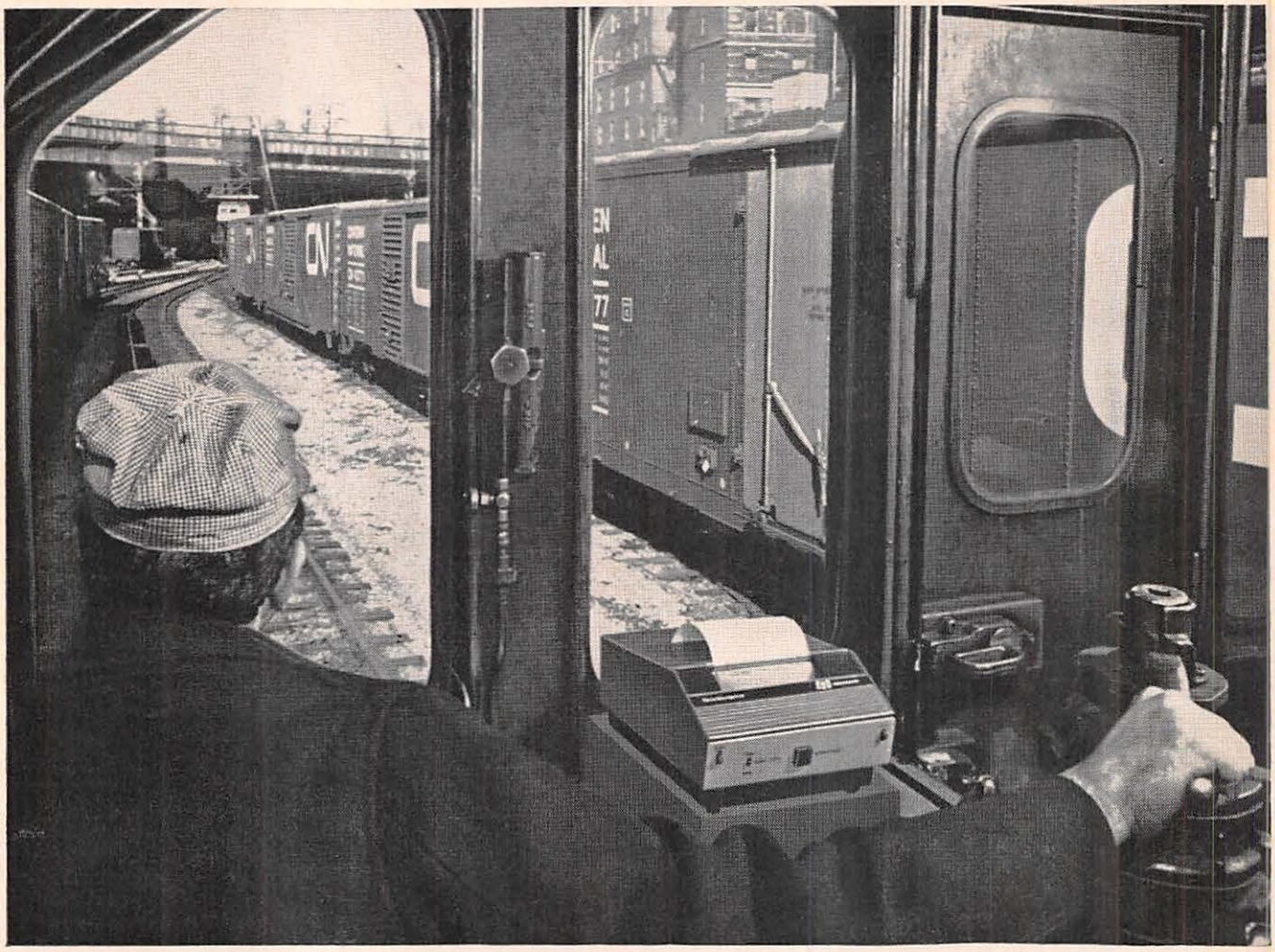
There are plenty of "good" microwave systems around. But maybe you're in the market for something more. Call it experience. Call it reputation. Whatever it is, a lot of people think Lenkurt has it.

So if you care enough to send the very best, just tell us your application. We'll do the rest.

Lenkurt Electric Co., Inc., San Carlos, California.

LENKURT ELECTRIC
GENERAL TELEPHONE & ELECTRONICS

Microwave Systems from Lenkurt



When Tom Toscano is busy moving freight, Kleinschmidt can take his messages.

Put Tom Toscano at the controls of a 45-ton locomotive and he's concentration itself. That's why a Kleinschmidt Telescripter® can be so valuable.

The Telescripter eliminates the distraction of voice messages. It prints them instead. At 100 words per minute. Time designations. Track numbers. Car numbers. Freight sequence.

If Tom has to leave the engine, the Telescripter messages can be there waiting when he returns.

Back in the caboose, the Telescripter can give the crew a record of all destinations and orders automatically.

This marvelous little machine plugs into any two-way radio. And because the messages are printed instead of spoken, they're always free of static and interference.

For full details about the Kleinschmidt Telescripter, write to Kleinschmidt, Division of SCM Corporation, Deerfield, Illinois 60015. Telephone (312) 945-1000.

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FCC has adopted rules authorizing issuance of regular licenses for vehicular use of radioteleprinters in Police, Fire and Railroad Services, effective August 27, 1969.

Circle 11 on reader service card

News Briefs

● CHICAGO TRANSIT AUTHORITY placed its 10-mile Dan Ryan rapid transit system into operation Sept. 28. The $51 million line runs from the Loop south to 95th street, most of the way in the median strip of the Dan Ryan Expressway. High frequency track circuits for cab signaling were supplied by General Railway Signal Co.

● BART'S automatic train control system has now reached the stage where programming for the computer controlled operation has begun. (See RS&C July 1969, pages 27-38).

● CANADIAN NATIONAL has ordered CTC equipment from the Signal & Communications Division of WABCO for installation on 33 miles of double track between Hamilton West and Paris West, Ont. Control will be from a TCC pushbutton console at London, Ont.

● MISSOURI PACIFIC has ordered equipment for a traffic control system from the Signal & Communications Division of WABCO, to be installed on 110 miles of line from Woodland Jct., to Findlay Jct., Ill. The control machine will be located at Chester, Ill.

● NORTHERN PACIFIC has awarded a contract for the installation of five automatic car identification systems to Sylvania Electric Products Inc. Three of these KarTrak ACI systems will be installed near the Pasco, Wash. yard and one, each, at Northtown and Park Junction, near Minneapolis, Minn.

● TEXAS & PACIFIC has ordered automatic freight classification yard equipment for installation at Lancaster Yard, Fort Worth, Tex. from the Signal & Communications Division of Westinghouse Air Brake Co.

Railroad Personnel

● CHESAPEAKE & OHIO/BALTIMORE & OHIO: **G. J. Bowerman** appointed circuit engineer signals; **J. A. King** appointed junior circuit engineer signals; **C. L. Horne** appointed junior circuit engineer signals; **J. E. Zornes** appointed signal application engineer; **H. F. Cummings** appointed senior engineer signal estimates; **J. L. Marsh Jr.** appointed engineer signal estimates; **J. R. Winter** appointed circuit engineer signals; **C. J. Nicely** appointed junior circuit engineer signals; **A. J. Toney, Jr.** appointed signal application engineer; **R. L. Brown** appointed senior circuit engineer signals; **C. E. Watson** appointed circuit engineer signals and **J. C. Elkins** appointed junior circuit engineer signals, all with headquarters at Huntington, West Va. **R. B. Lang** appointed supervisor communications services with headquarters at Baltimore, Md.

● CHICAGO SOUTH SHORE & SOUTH BEND: **John R. Dukehart** appointed signal and electrical engineer. Mr. Dukehart began his railroad career with the Baltimore & Ohio in 1951 in the signal department after studying electrical engineering at Purdue University. Following this experience he moved into the motive power department. His most recent position was as industrial engineer in the planning department.

● DENVER & RIO GRANDE WESTERN: **M. J. McLaughlin** appointed engineering assistant, signal department at Denver.

● GREAT NORTHERN: **R. A. Lehrke,** formerly sales and service representative, Railroad Accessories Corp., appointed signal engineer-planning.

● ILLINOIS CENTRAL: **George McCann** appointed chief clerk to director of public relations. Mr. McCann was formerly secretary, Communication & Signal Section, AAR.

● NORTHERN PACIFIC: **Frank H. Coyne,** vice president management services, appointed vice president finance. **George W. Thompson,** director operating data systems, appointed director of management services.

Supply Trade News

● DIVERSIFIED DISMANTLING CORP.: **Gerald J. Aul,** vice president, appointed president and also appointed vice president of Diversified Metals Corp.

● GENERAL ELECTRIC CO. has formed a new communications systems division with headquarters in Lynchburg, Va. Division general manager will be **Richard P. Gifford** who has been general manager of the communications products department. The new division includes a telecommunication products department, formerly the communication products department; a communications and control devices department at Waynesboro, Va., formerly the specialty control department; and the mobile radio department.

● GENERAL RAILWAY SIGNAL CO.: **Sydney W. Freeman,** vice president—engineering, appointed senior vice president. Mr. Freeman, a graduate of Rochester Institute of Technology and also holding a degree in electrical engineering from New York University, joined GRS in 1925 as an electrical engineering co-op student. For three years he worked on New York City subway installations and later spent four years in Rio de Janiero representing a British affiliated GRS company. He joined the New York sales office in 1944 and, in 1952, was named manager there. A year later he was appointed sales manager and, in 1955, promoted to executive assistant to the president. In 1958 Mr. Freeman was appointed vice president—engineering. In his new position as senior vice president he will be responsible for advanced planning projects.

● KERITE CO.: **John B. Gardner,** chief engineer, elected vice president of engineering. A native of Boston, Mr. Gardner has a degree in electrical engineering from Massachusetts Institute of Technology. He joined Kerite as an electrical engineer in 1947 and was appointed chief engineer in 1964.

● REZOLIN INC.: **Bruce E. Hanson** appointed southeast district sales manager at Memphis Tenn.

● ROHN MFG. CO.: **Kenneth Cordrey** appointed sales manager for the east coast area.

● SIMMONS-BOARDMAN PUBLISHING CORP.: **Charles E. Keil** district manager, New York for advertising sales coverage including Railway Signaling & Communications promoted to regional sales manager there.

Roger A. Lehrke
Great Northern

Gerald J. Aul
Diversified Dismant.

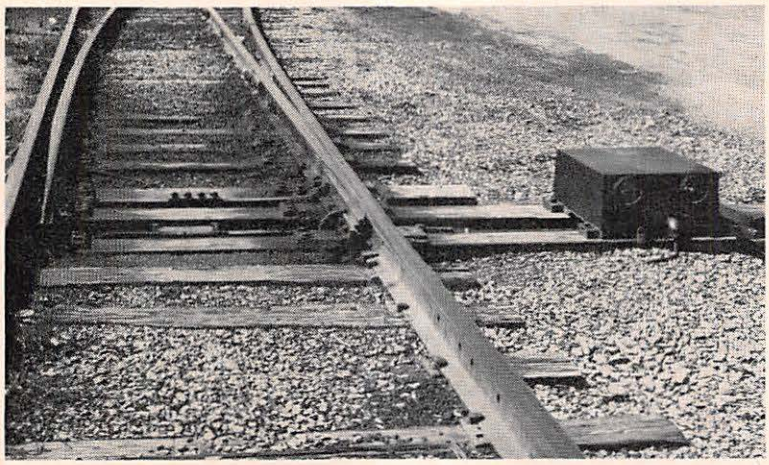
Richard P. Gifford
General Electric

Sydney W. Freeman
General Ry Signal

John B. Gardner
Kerite Co.

Kenneth Cordrey
Rohn Mfg. Co.

NEW DEVELOPMENTS by GRS

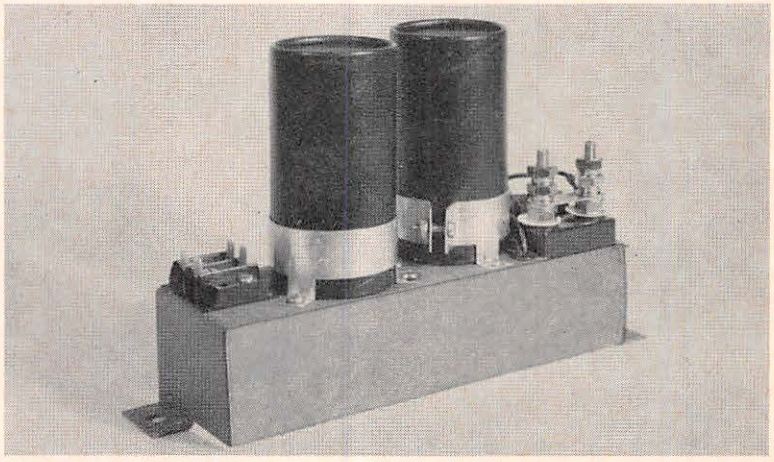


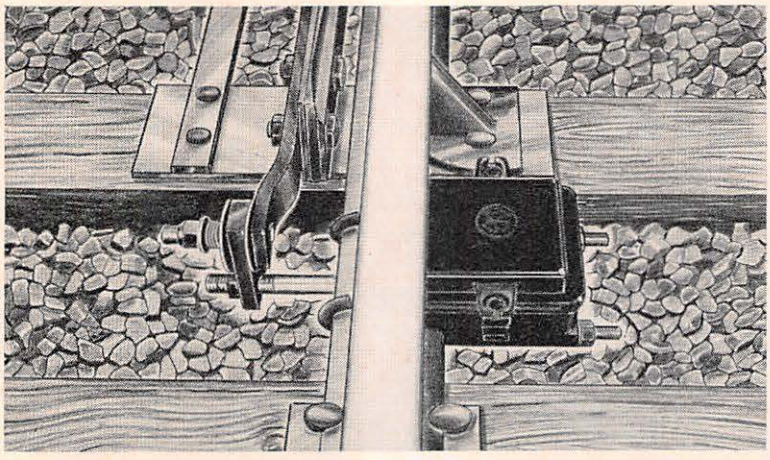
Speed-Frater™ Switch Machine for Noninterlocked Switches

Ideal for receiving, departure, and industrial yards. Basic machine is reversible in midstroke, has handthrow lever and indication contacts. Automatic restoration is available, as well as built-in indication lights. Ask for PD-25 for more information.

D-c Power Filter Unit for Lightning Protection

Protects sensitive electronic circuitry from lightning and other high voltage surges. Combined with standard lightning arresters, the filter provides superior protection for overlay track circuits, carrier, and any other battery-operated electronic equipment. Ask for PD-23





Model One Switch Point Detector Rugged, Compact, Rail Mounted

Easy to install, practically no maintenance. Two contacts, normally closed or normally open, are actuated by a plunger connected to the switch point. Ask for D63.0101 for more information.

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Circle 10 on reader service card

C&S men told to improve image

MONTREAL, QUE. Sept. 16-18, 1969: More than 1400 people gathered at the Queen Elizabeth hotel to attend the ninth annual meeting of the Communication & Signal Secton, AAR. Fifty-four railway suppliers displayed more than $10 million of new products and systems in 89 exhibit booths.

Canada's great new experiment in transportation policy is working well, reported Commissioner J. A. D. Magee, Canadian Transport Commission. The new policy which applies to rail, air, waterways, buses, trucks and commodity pipelines is designed to provide an economical, efficient and adequate transportation system for the best use with lowest total cost to users. For railways, the new policy set them free of many rate regulations, and enabled them to set rates to meet the demands of the market place. Railroad rates must be compensatory in that they exceed variable costs, Magee said.

C&S: New Outlook

Communications and signal men must widen their outlook and at the same time make their work understandable to railway management. Keynote speaker Eric P. Stephenson, vice-president, Canadian National, and former engineer of signals said: "Some of the remarkable features of present day C&S technology lies in the ability to sense or detect many different states or conditions for direct input, that is without human participation, into systems serving the railroads. The sensory elements which can be incorporated can feel, see, hear, detect magnetic fields induced in many ways and having infinitely variable characteristics, detect electric currents and so on. The digestive parts of the system can scale, count, calculate and compare and either effect controls directly or display information in many ways. The location, far or near, where any of these activities are performed is not prescribed by technical limitations.

"There may be some tendency to look upon these systems as only extensions of data processing because both use computers. The essential and character determining feature of the systems of concern to you is that they have a real life, real time quality which makes them capable of controlling processes of our industry. The systems sense, consider (to a programmed line of reasoning) and control the production process.

"The practical technological developments that permit the new systems to be introduced are only of potential value until they are put to use. For this reason I think the really significant development to our society and more particularly to the railways is that nontechnical people are becoming aware of this potential and the meaning of it all.

"What this means," Stephenson said, "is the beginning of a new kind of revolution. This one has to do with substitutes for human sensing capable of being extended indifinitely in space and substitutes for thought processes.

"It is your role in this new revolution that is exciting. In it there can be no separate signals or communications serving the railways. Also some technical people with skills which complement your own but who are scattered through other departments should be in closer working relationships with you or should be in your ranks."

"Would you please try to make it easier for those who do not speak your language but are interested in your work? It is a difficult language—a precise language—one very strange to the ears of others. It is a language that is constantly being enlarged and adopted. Nobody in management, myself included, can fully bridge the language gap between us. Most general managers have been much less exposed to your language than I have been.

"In your efforts to get better understanding in the present climate, which is much more permissive for it than has previously been the case, you might consider the desirability of changing your name. Communications

Keynoter E. P. Stephenson is vice-president, Canadian National.

J. A. D. Magee is commissioner of Canadian Transport Commission.

Chairman H. R. Beck presided at ninth annual meeting of Communication & Signal Section, AAR, in Montreal.

Peter D. Bonin, secretary, C&S Section, AAR, gave Committee of Direction report.

and signals both have connotations from a past which is gone forever, but leaves you with a language legacy which, I think, has recently become a liability to you and the railways. You might bear in mind that most individuals in general management probably will have had little recent opportunity to up date their knowledge or notions of the physical plant they once may have known well. Perhaps you might be better described as systems engineers or the cybernetics department. Whatever you call yourselves, make it convey as accurately as you can what you are and what you do today," Stephenson said.

"In serving the railways it is not good enough for you only to put in a remote controlled switch or a message switching center or even blocks of CTC or an automatic yard when asked to do so. You must do more than that. The railways need your advice, good advice about comprehensive systems and where they should be introduced.

"I mentioned the growing awareness of non-technical people of the nature of the new revolution. You now have to help them understand specifics. It is important that through you, managements come to recognize how to provide the railways with new operating and management systems. Systems that make words like centralization and decentralization take on completely new meanings without provoking historic reactions to violated doctrines because the doctrines will have been outmoded in many respects. The systems you fashion will necessitate staff regrouping and reorganizing throughout the railways for greater external effectiveness and internal efficiency Managements would be freed to concentrate more on managing, with many routines of operations and administration left to be handled by the new systems," Stephenson said.

"I suggest as a practical matter that you help others understand your work and your potential through a planned educational effort. This might include a series of discussions, the presentation of papers, aimed at your audiences not yourselves, and any other ways that are likely to improve understanding.

"If you succeed even moderately in your efforts at improving understanding you will be participating as a practical matter of fact in the general management processes of your companies. To that extent you can reasonably expect to occupy positions accordingly. Vigorous leadership is expected of you. Provide it in full measure," Stephenson concluded.

Microwave Systems

Although microwave systems are designed for a specific maximum capacity, they may become overloaded. Usually this occurs in a mainline hop, said Robert F. White, senior staff engineer, Lenkurt Electric Co. "A hop can be said to be overloaded when one or more of the following limits has been passed: (1) All of the available or usable baseband spectrum is in use. (2) Total baseband signal power (system loading) at point where any increase would cause an unacceptable degradation in performance. (3) System usage such that any increase in either the top baseband frequency or the system loading would cause the emission bandwidth to exceed that allowed by FCC for the particular frequency band," White said.

"Several tools are available to the user of a microwave system which is at or near the overload point. (1) Replace inefficient multiplex with single-sideband, suppressed carrier multiplex if applicable. (2) Sectionalize the system by use of baseband blocking or multiplex interconnects at suitably chosen intermediate points, so that channels occupying the same baseband spectrum can be reused in different sections. (3) Evaluate the possible effects of increasing the number of channels or the loading of the microwave hops beyond their original design capacity, to determine whether such an increase is technically and legally feasible.

"(4) Carefully review noise performance objectives to determine whether a modest relaxation will permit the desired capacity increase without significantly affecting system usage. If heavy data loading is the problem, evaluate the possible affect of reducing the data loading by reducing the level at which it is applied to the channels.

"(5) If other measures prove inadequate, consider the possibility of upgrading the microwave system itself, or at least the heaviest loaded portions, by such things as increasing antenna sizes, changing out intermediate frequency filters to provide wider bandwidth, etc. In some situations these changes may be relatively simple and inexpensive in comparison to the increased capacity," White said.

Calculations have been made, using a computer, to compare reliability of

C. J. Nelson, general superintendent communications & signals, Rock Island, is newly elected second vice-chairman of Communication & Signal Section.

J. N. Albertson is first vice-chairman of the C&S Section.

nine different types of microwave equipment configurations operating in coastal, inland and mountainous areas and with varying path lengths. John L. Williams, manager electrical reliability department A, Collins Radio Co., said that a figure of merit was developed with a base of 1,000. This applies to a non-standby, non-diversity system.

An example of the type of calculations developed is a graph showing the annual per-hop outage vs path length. The following figures of merit are approximated from the graph covering path lengths of 10-60 miles:

System	Figure of Merit
Non-diversity, non-standby	1,000
Space diversity without standby transmitter, switched or combined receivers	550
Hot standby with switched receivers	1.5 to 175
Hot standby with combined receivers	1.0 to 125
Crossband diversity with switched receivers	0.9 to 4.5
Crossband diversity with combined receivers	0.9 to 3.5
Space diversity, hot standby transmitters switched receivers	0.49 to 3.3
Space diversity hot standby transmitters combined receivers	0.5 to 2.5

"The problems which can be attributed to differences in absolute transmission delay between the two branches of a line-of-sight space diversity system can have a serious effect on system end-to-end performance. The magnitude of these differential delays is such that the problem begins to become significant with 300 voice channel basebands, and gets worse very rapidly as the baseband is expanded beyond this limit," said Jorgen H. Bistrup, manager systems engineering, Farinon Electric.

"A line-of-sight space diversity arrangement typically consists of a single transmitter driving a single antenna, and two separate antennas employed to receive the transmitted signal. The two receiving antennas are usually vertically spaced, and the antennas are either mounted directly on a tower and connected to the receivers via long runs of transmission lines, or the system is comprised of two tower mounted, and vertically separated, passive reflectors, each illuminated by an antenna located on or near the radio equipment building.

"The diversity action in both systems is achieved by intentionally creating two separate paths of transmission, and since the paths are separated vertically, one path invariably has a greater length than the other. It is this difference in length between the two branches of the diversity system which results in a difference in the total transit time of transmission between the paths, or in other words, there is a difference in the absolute delay of one path versus the other. The problem we are concerned with is the magnitude of this differential delay, and its relative effect on a microwave system which utilizes baseband combining," Bistrup, said.

The solution to the problem is to provide the necessary equalization. Three approaches are available. "(1) Equalization at RF frequency could be accomplished by the addition of an appropriate length of transmission line to the shortest branch of the space diversity configuration. This approach however would be difficult for any system other than one which used a flexible type of transmission line with tower mounted antennas. In general it would be considered as a less desirable solution.

"(2) Equalization at the IF frequency using a lumped constant type equalizer. This type of equalizer, or delay line, is commercially available at the range of values most likely needed, and it could provide an adequate and reasonable solution.

"(3) Equalization at the baseband frequencies would also be by a lumped constant type of equalizer. In general this would appear to be the most attractive way of achieving the equalization required. It might be possible to provide an equalizer with several optional values. thereby facilitating performing the equalization on a customized basis for each installation, and essentially provide an optimum corrective solution," Bistrup said.

Data Terminals

The selection of terminal equipment for a data communications system depends upon many factors in order to obtain the most efficient system. Dan Printz, marketing communications man-

ager, and M. A. Pedote, regional sales manager, Teletype Corp., listed such factors.

–Volume of data traffic and its urgency.

–Distribution and language (form in which information communicated).

–Functions equipment must perform.

–Speed of transmission.

–Accuracy.

–Cost.

Functions of each terminal must be determined, such as input and output requirements, information retrieval, message switching, receive only, send only, or both send and receive. Also to be considered is direct input to or output from a computer.

Train Length

With today's freight cars ranging in length from 40 ft to 89 ft, there is the need to know the length in feet not just the number of cars in a train. This is especially important when passing trains at sidings or for yarding trains on receiving tracks. Capacities for such trackage is usually expressed in car lengths based on 40, 44 or 50 ft cars.

William L. Geiger, general manager electronics division, Erico Products Inc., described a train length computer system. It consists of two light sources and two transducers or photo receivers. The receivers are located accurately on 10 ft centers angled in such a way as to just miss the top of the highest coupler and catch the bottom of the lowest depressed center car.

"Five separate conditions exist in the operation of these photo receivers: (1) No trains. (2) Train approaching and presence established gating the receivers into readiness and turning on the light sources. (3) Photo beam 1 is broken. (4) Photo beam 2 is broken. Conditions 3 and 4 alternate to the end of the train with at least one beam broken at all times. (5) At the end of the train both beams are restored at the same time, duplicating in reverse condition 1. This freezes the accumulated count for readout transmission.

"Breaking of the first beam by the engine starts a 100 kHz count. This count is constantly divided by 10 and stored on channel B ceasing when beam number 2 is broken. After beam number 2 is broken, the same 100 kHz signal starts to build on channel A. Every time A counts as high as the stored figure on channel B a one count appears on the visual readout. This condition exists for the length of a car plus the gap to the next car's leading edge. Each time the leading edge of another car passes through the two beams the original figure stored in channel B is updated by the passing of that car," said Geiger.

"Three methods of telemetering information from inspection to readout points have been developed. For close operation up to 8 miles where land lines are available, a system would consist of two photo receivers and one train length computer (TLC) with two signal pairs interconnecting.

"For operation where land lines are not available, and carrier can be used, two carrier up-shifting with one carrier on signal, for train presence indication, will transfer all data limited only by range and efficiency of the carriers themselves. An interface between the carrier receivers and the TLC inputs is the only other item required.

"For long distance transmission where time sharing of already crowded circuits is a must, we have developed a BCD to serialized converter which will transmit from the computer to a numerical remote readout, in ¼ second bursts, all accumulated information. This can be arranged to transmit on demand or automatically with a non-destructive readout, as many times and to as many places as desired, anytime after a train has cleared the inspection point. At this time, either two-way signaling or initiation of a new train presence signal will cancel and reset the computer for the next train," Geiger said.

Train Control

Automatic train control systems can be compatible with existing signal systems, but ATO affords improved operations with increased density of traffic and increased train speeds. Homer L. Hathaway, manager systems planning, Signal & Communications division, WABCO, described such ATO systems. "With a train control system, the expense of installing and maintaining wayside signals can be eliminated or drastically reduced.

"It is becoming more difficult to train crews in proper train handling. Wouldn't it be much simpler and more economical to redesign the throttle and brake stand, so that an engineman with a lower level of skills can operate a train using speed command pushbuttons only? The train control equipment would perform the routine tasks required to operate the train properly.

"Today we have available several systems which are capable of providing various degrees of control from merely checking the position of a signal being passed to completely automatic train operation without the need for an engineman to perform the routine train handling functions."

(Text continues on page 20)

Committee Reports

A- Outside Plant Facilities. W. L. Mansfield, C&NW, chairman, reported. The following manual parts were approved for elimination from the Signal Manual: 41, 62, 65, 151, 152, 153, 174, 221, 245, 246, 252, 264, 265 and 266. Information reports accepted included: weed and brush killers, rare gas protectors, experience with ACSR conductors, dampening aerial cable, National Electrical Code activities and new housing for work forces.

B- Radio and Microwave Systems. H. C. Macomber, MP, vice-chairman, reported. The following manual parts were approved for elimination from the Communication Manual: 12-2, 12-4, 12-5, 12-6, 12-7, 12-8, 12-9 and 12-14. Approved to supersede subject matter in the Communication Manual were manual parts 12-17 requirements for tone operated control equipment to provide remote control of radio transmitters, receivers and accessories; and 12-23 minimum performance requirements for long-haul, high-capacity microwave system. Information reports accepted included Government activities affecting the status of railroads with respect to radio; Communication & Signal Section circulars 245, 246, 248-250, 252, 253, 257, 260-262, 266-268; statistics on railroad radio authorizations, inductive carrier installations and microwave point-to-point systems; activities and developments in connection with radio services of other organizations; mobile radio teleprinters for public safety communications; and wind-driven and other special power supplies for microwave repeaters.

C- Communications and Data Systems. A. S. Walker, CP, vice-chairman, reported. The following manual parts were approved for elimination from the Communication Manual: 2-G-12, 2-G-13, 2-G-14, 2-G-27, 2-G-28, 2-H-6, 2-J-6, 2-J-11, 2-K-22 and 2-K-24. The following information reports were accepted: recent developments in power supply equipment, thermo-electric generators; error control; measurement of data transmission through data sets; and radio control using railroad telephone dispatching circuits.

D- Highway Grade Crossing Protection. J. W. Gavey, WP, chairman, reported. Drawings 1463C and 1465A were approved for elimination from the Signal Manual. Drawings 1484B, 1485B, 1647C and 1696C were approved to supersede subject matter in the Signal Manual. AAR Signal Requisites solid state flasher were approved for inclusion in the Signal Manual. Information reports accepted covered noteworthy developments of railroad-highway grade crossing protection devices; methods to improve effectiveness of railroad-highway crossing protection devices; experimental marking for highway grade crossings; experimental railroad crossing signs; interconnection of highway grade crossing protection with street traffic signals; and report on rail-highway grade crossing safety conference.

A- W. L. Mansfield, C&NW, reports.

C- A. S. Walker, CP, reports.

D- J. W. Gavey, WP, reports.

B- H. C. Macomber MP, reports.

E- O. C. French, AT&SF, reports.

E- Interlocking, Traffic Control & Block Signal Systems. O. C. French, AT&SF, vice-chairman, reported. Manual Parts 68 and 74 were approved for elimination from the Signal Manual. Approved to supersede subject matter in the Signal Manual was part 104 specification for electric motor switch operating mechanism. Information reports accepted included rail clip with fiber glass insulation; specified elements of train hour cost with road freight hours, 1967; and basic principles for electronic controls for railway signaling systems.

F- Car and Engine Control Systems. R. D. Liggett, SCL, chairman, reported. Two manual parts were approved to supersede subject matter in the Signal Manual: part 251 AAR signal specification on classification yard control consoles, revised; and part 42 signaling for gravity classification yards. Accepted as information were reports covering characteristics of bolometers and photon detectors; application of inert car retarders; and wheel marking system.

G- Education and Training. G. W. Vogen, CN, reported. Two information reports were accepted: Subcommittee 2- signals, is continuing its assigned task to revise and rewrite the various chapters of American Railway Signaling Principles and Practices, and to prepare the revised booklets into a suitable training format. This is a time-consuming procedure which requires considerable individual effort. For this reason, the approach taken by the Committee was to assign each member one or more chapters to complete on an individual basis. Assignments have been made and this work is presently underway. It is the intent to revise all chapters to entirely replace the present booklets. The design of the revised issues will be suitable for reference purposes as well as being usefull as training course material. Material content and method of binding is being given consideration to insure, that in the future, article material can be revised from time to time as required without replacement of an entire chapter as at present.

Under assignment 3, additional texts are being reviewed by members of Subcommittee 1- Communications, to determine usefulness and adaptability as training course material for communications employees. Publications found suitable will be included in a bibliography of recommended training courses which is being compiled. In addition the Committee has done considerable work in developing a Flexible Building Block Plan which will provide a framework for individual railroads to use when designing training courses for employees. The purpose of the building block plan is to provide a uniform method of selecting pertinent courses to insure training is adequate, but on the other hand that employees are not over trained.

To aid in the aforementioned work, two circulars are being distributed to the senior representatives, and to designated manufacturers. The circulars request information as to items such as training method, materials, aids and techniques, book and courses which railroads and manufacturers may now use, and which they would recommend for training of employees. Assistance offered in replies to these circulars will be most helpful and will certainly be appreciated by the Committee.

F- R. D. Liggett, SCL, reports.

G- G. W. Vogen, CN, reports.

D. H. Green, CN, (far right) led panel discussion on hotbox detectors. Members included (left to right) B. L. McNeill, Jr., WP; R. A. Howell, SOU; and A. J. Glazar, Servo Corp.

R. D. Liggett is newly elected first vice-chairman of C&S Section.

J. N. Albertson, SP, (left) incoming chairman, presents plaque of recognition for leadership to retiring chairman H. R. Beck, CN, assistant chief engineer-administration.

Starting with the basic coded AC track circuit energy that provides cab signals and adding speed command data will reduce or eliminate the requirement for a pole line. Add an electronic tachometer to measure actual train speeds and the ability to compare requested speeds with actual train speeds is provided. "With the two basic inputs of speed commands and speed sensing on board the locomotive, a choice of several train control modes is readily available:

"(1) Display the signal in the cab and depend on the engineer for proper handling of his train. A speed sensor is not required here except to provide a speedometer. (2) Along with speed sensing, and logic to provide overspeed detection and control and thus automatically monitor the engineman's performance. (3) With the addition of a Velocity Control Programmer, but without receiving speed signals automatically, the old throttle and brake control stands can be eliminated in favor of a pushbutton speed selection panel to be operated by the engineman. This would provide automatic train handling. (4) Install full ATO which uses both speed commands and actual speed inputs along with the VCP to obtain full automatic train operation and automatically perform all routine train handling duties of the engineman," Hathaway said.

"Canadian National's Great Slave Lake operation runs 430 miles through northern Alberta and the Northwest Territories. Over-the-road operation is automatic with an operator riding the locomotive and a conductor in the caboose. Speed commands are delivered to the locomotive intermittently via an Identra train identification system where inert tuned coils are placed between the rails. The active portion of the train identification system is locomotive carried. Three different speeds are provided: 15, 22 and 40 mph. In addition, the Identra equipment delivers a grade command and a grade crossing whistle command.

"In order to assure that a speed command is not overlooked, an intermittent train stop device is located in advance of the Identra coil. When the locomotive passes over this stop, the previous speed command is cancelled. If a new speed command is not received within six seconds, a full service brake application will occur.

"This control system is programmed to automatically handle propulsion, dynamic brake and train air brakes for 100 cars as dictated by terrain and train dynamics. When a train is made up and ready to leave the terminal, an automatic starting sequence is programmed to release brakes and pull slack before the throttle is advanced

to obtain proper speed," Hathaway said.

Bart Controls

Controls for San Francisco's Bay Area Rapid Transit District will be centralized at the Lake Merritt station in Oakland (See RS&C July 1969 page 27). The dispatcher will communicate with the computer via Teletype KSR 35 units. Also he will have CRT diplays and hard copy printouts from the KSR 35. One of the special facilities available to the dispatcher is a malfunction display panel and controls. Thomas R. Gibson, project manager, transportation division, Westinghouse Electric Corp., described this facility.

"A malfunction display panel is for alarming malfunctions associated with the support facilities. It is actually the screen of a rear projection slide projector. It is the intention of BART that the facilities drawings that might be required in an emergency, or perhaps frequently, will be reduced to slides and stored within the projector unit. A thumbwheel panel below the screen is used to access any one of a possible 1,000 slides that may be stored.

"The emergency telephone system is a wired system with telephones located frequently throughout the underground sections, in agents' booths and at yards. Any of these emergency phones coming 'off hook' will cause the appropriate 'E' symbol on the display board to flash, and the appropriate selector key on the console to light. Depressing of the illuminated key by the operator connects a red phone to the correct line, stops the flashing 'E' symbol, and starts two tape recorders. One of the recorders, located in the console, is the short time continuous loop type, while the other located downstairs in the equipment room is used as the permanent record device. In addition to this audible record, a printed record is produced on the KSR 35 Teletype. This record will contain the time that the phone line is activated and the station identifier symbol. Other alarms associated with the 'support' facilities are similarly logged on this KSR 35 typer," Gibson said.

"In the BART system, all manual controls to train control, electrification and support facilities are routed through the computer where the keyboard inputs from the consoles are converted into the proper data words and passed to the data transmission system. Likewise, all incoming data from the data transmission system is routed through the computer where it is analyzed and appropriate action is taken. For example, change a track section from white to red to indicate occupancy. The data bit indicating this will be read, recognized and an appropriate bit sent to the display board lamp drivers.

"Much of the data processed through the computer is not associated with manual commands or display functions. For example, routing maybe handled automatically on the basis of schedule information: ACI data from trains departing yards is coupled to train ID numbers and used to maintain records of car miles and hours; and in the power area, power consumption analysis can be made on the basis of data brought in from remote sensors," Gibson said.

Computer Control

"The decision to provide the Southern Alameda yard of BART with an interlocking machine opened up a potential area for utilization of an advanced interlocking system. The BART specification for interlocking the yard control system permits the use of a general purpose digital computer as an alternative to conventional AAR recommended designs. However, this alternative must meet performance standards equivalent to those recommended by the AAR. A general purpose digital computer is used in the consolidation of system tasks, and manual back-up provides for operation during computer failures," said John L. Blake, engineering specialist, industrial systems and products operations, Philco-Ford Corp.

From the basic design of the Alameda yard project, a computer consolidated protection and supervision system was developed. The basic portions of the system are: (1) central processing unit, (2) core and disc memory, (3) vital logic and devices, (4) non-vital logic and devices, (5) cathode ray tube logic and displays, (6) automatic car identification logic and scanners, and (7) remote vital device interface and logic.

Train System

The basic characteristics of AAR's TeleRail Automated Information Network were described by John P. Gardes, manager telecommunications systems, Management Systems Department, AAR. "Essentially we will have a data collection facility and, as a by-product, we will have some query capability. We will have a two-way transmission system. Communications will be on-line, that is, computer controlled. Transmissions of interchange data will be nonscheduled. TRAIN dial-up intervals will be somewhere between 15 minutes and an hour depending on our experience with the system.

"We will not have a back-up capability. If we have trouble with the computer or with the lines, we are just out of business for a few hours. For our communications lines we will use outward WATS. We will have four lines: Zone 1, Zone 3, Zone 4 and Zone 6. The outward WATS will give us the ability to call the railroads to bring in their information," Gardes said.

"Based on our present statistics, we anticipate a line loading of 48 hours total. This should mean approximately 12 hours each line per day. The characteristics of the telephone lines means that we will have maximum transmission speed of 2,000 bytes per second. We will establish our connection by dialing, that is, automatic dialing performed by the computer programs. In the initial phase of TRAIN we will provide a selection between two transmission devices for small-volume roads and two others for the large-volume roads [See RS&C Mar. 1969 page 17 and Sept. 1969 page 28]. In subsequent phases of the system we anticipate an even broader variety including CPU to CPU communications. At the present time, we are investigating other devices, CPU to CPU included, magnetic tape and others," Gardes said.

Surge Protection

"The advent of vacuum tubes followed by transistors and most recently, integrated circuits, has reduced the signal levels in some railroad signaling and communication equipment from the neighborhood of a hundred volts to as little as a few millivolts, and the response of the circuitry from seconds to microseconds and even less. Whereas formerly an intermittent surge level of 2,000 volts and a continuous noise level of up to 10 volts were acceptable, modern complex electronic equipment and computers can tolerate surge levels of only a few volts and continuous noise levels of a few millivolts," said Norman A. Bolton, advanced project engineer, General Railway Signal Co.

"The arresters and lightning protection techniques that have in the past been satisfactory, are still quite useful but today the surge levels they allow must be reduced by a second and in some cases even a third device to the surge levels transistorized equipment can tolerate. In general, the arrestors we have been familiar with are sufficiently rugged to withstand the greatest part of the surge. The equipment with which we must now become familiar is that which will shield the transistor from that remaining part of the surge which the arrester allowed to pass. Part of this new equipment is a more rigorous way of wiring; and a more thorough

(Please turn to page 28)

Onboard controls handle locomotive from creep speed at loading to 50 mph on the mainline.

MUSKINGUM ELECTRIC:

How on-board controls work

By Robert J. Hopkins
Electronic Equipment Engineer
Automation Engineering
Transportation Systems Division
General Electric Co.

The function of the on-board automation equipment is to provide speed maintaining for the locomotive on all portions of the track from creep speed in the loading area to 50 mph on the main line. The automation equipment receives the speed commands from the communication equipment, translates this information into a speed reference voltage which is compored to actual train velocity, and maintains this speed by applying either power or brakes, whichever is necessary. The ATO (Automatic Train Operation) equipment also insures the safe operation of these locomotives by providing checking and other protective circuits.

In this completely automated system, the ATO equipment is designed on fail-safe closed circuit principles, so that a broken wire or failure of any device in the circuit will result in a more restrictive mode of operation or a stop.

The block diagram of the ATO system is shown in Figure 1. The safety circuits include tachometer check, overspeed check, reference check, card check, and logic circuit check. Each is in series with the ATCR (Automatic Train Control Relay) relay which when de-energized causes the SCMV (Safety Control Magnet Valve) to drop out which then applies full air brakes (a reduction to zero pounds brake pipe) at a controlled rate, removes power from the locomotive, and sets a zero speed command into the speed regulator. ATCR has a time delay on dropout of 6 seconds to avoid nuisance trips as the locomotive must be manually reset once a safety control occurs.

The tachometer check circuit continuously monitors the outputs of the two tachometers and keeps a relay energized as long as the differential between the two signals is not more than a specified amount. If this differential exceeds the specified amount the tachometer check relay drops out which drops out ATCR if it lasts for more than 6 seconds. The 6 seconds allows ample time for recovery after a wheel slip or slide.

The tachometer check circuit consists of an operational amplifier, an oscillator, and a relay driver. The inputs to the amplifier are the two tachometer voltages, a DC bias voltage, and a 4KHz square wave from the oscillator. The resultant output of the amplifier is an AC signal which is the input to the relay driver circuit. As the differential between the two tachometer voltages increases, the amplifier will go into either positive or negative saturation. This loss of AC signal into the relay driver circuit de-energizes the tachometer check relay. The relay driver circuit isolates the relay driver power from all power sources except the AC signal from the amplifier by means of a transformer. This insures that the AC must be operating

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and passing through the complete circuit before the relay can be energized.

The overspeed check circuit is designed to protect the train against a runaway or excessive speed condition due to a system failure. The design is similar to the tachometer check circuit and uses the fail safe design philosophy. The inputs to the amplifier are the larger of the two tachometer voltages which has been selected by an analog "OR" circuit, an overspeed reference voltage and a 4 KHz square wave from an oscillator. The output of the amplifier is an AC signal as long as the velocity of the train does not exceed the limit set up by the overspeed reference voltage. If the locomotive exceeds the speed command by more than a specified amount the AC signal into the relay driver is lost and the overspeed relay drops out. If the overspeed condition is not corrected within 6 seconds, a safety control application of brakes is applied the same as for a tachometer check.

The speed-overspeed reference check circuit is used to guarantee the presence of a valid overspeed reference for each speed reference. The reference check circuit compares the voltage from the two reference generators for correspondence within the specified differential. Again an operational amplifier is used to make the comparison in a "fail safe" manner. The inputs to the amplifier are the two reference voltages, a DC bias voltage, and a 4 KHz square wave from an oscillator. The AC signal from the amplifier into the relay driver must be present to pick up the reference check relay. If the differential increases beyond the specified limits, the AC signal is lost and the relay drops out. This will also result in a safety control if not corrected within 6 seconds.

The card check function is a safety circuit which checks that all cards are plugged in which if left out would cause an unsafe condition on the locomotive. For instance, the f/dc card provides the velocity feedback signal to the regulator and if left out would cause a runaway condition to occur. An electrical interlock is used on these cards to interrupt the circuit to ATCR if they are not plugged in.

Speed maintaining is done by the closed loop principal of comparing actual velocity to a speed reference and generating an analog error signal to maintain the desired velocity. Two error amplifiers are used because of the wide range of speed commands in the system. The "lo speed" error amplifier is used exclusively for the creep command which is about ⅓ mph. The tachometer feedback signal is received from an axle mounted type MM54 optical tachometer which produces 360 pulses per wheel revolution. For a 40" diameter wheel this tachometer provides 51 pulses/mph. The output of the tachometer is fed to a Schmitt trigger and then a 3 msec single shot. The single shot provides constant volt second pulses which are filtered by an active filter resulting in a DC voltage proportional to velocity.This voltage is compared to the creep reference by an operational amplifier and the resultant voltage is a velocity error signal which is positive for power, zero for coast, and negative for braking.

A "hi speed" error amplifier is used for all other speed regulation. The tachometer feedback signal is provided by two axle mounted type MM24 magnetic speed sensors which produce 20 pulses per wheel revolution. For the 40" diameter wheels of the locomotive, the tachometer provides 2.76 pulses/mph. The output of each tachometer feeds a saturable transformer which provides constant volt second pulses which are rectified and filtered. The resultant DC voltage is proportional to velocity and scaled to +30.0 volts DC at 50 mph. These two velocity signals are compared in an analog "OR' 'circuit and the larger of the two

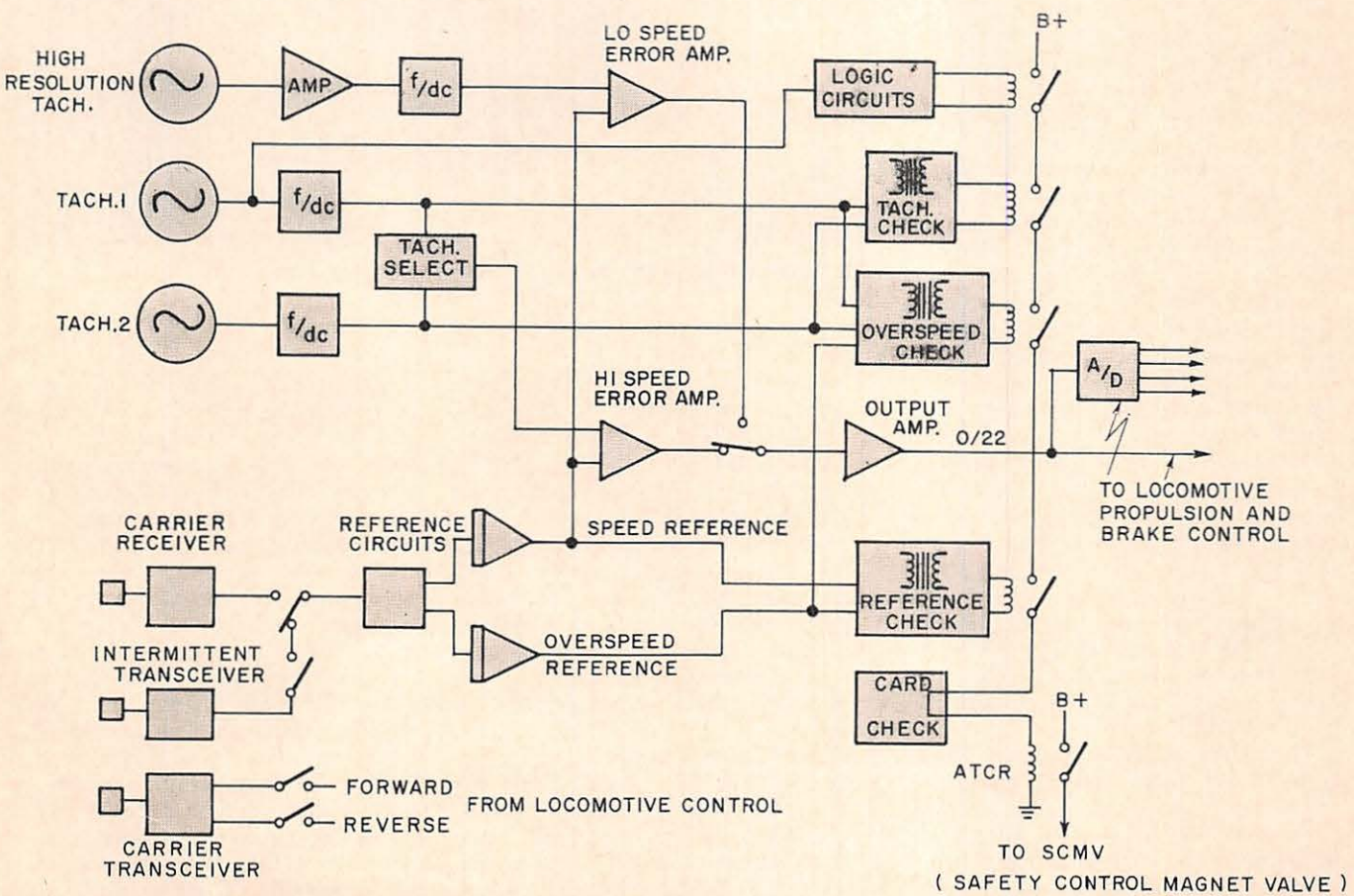


Figure 1—Block diagram of the onboard automatic control system.

is used for the velocity feedback voltage. This voltage is compared to the speed reference by an operational amplifier and the resultant is a velocity error voltage which is positive for power, zero for coast, and negative for braking.

The speed reference voltage, which is one input to each of the error amplifiers, is the output of the speed reference generator. The speed reference generator is an operational amplifier with a gain of -1 and a capacitor as a feedback component whose charging rate can be adjusted with a potentiometer to change accelerating and decelerating rates. The input to the amplifier comes from the speed command relays which when picked up feed an adjustable DC voltage to the amplifier scaled at 10 volts for 50 mph. The speed command relay contacts are arranged in a priority ladder which takes the more restrictive command if more than one relay is picked up.

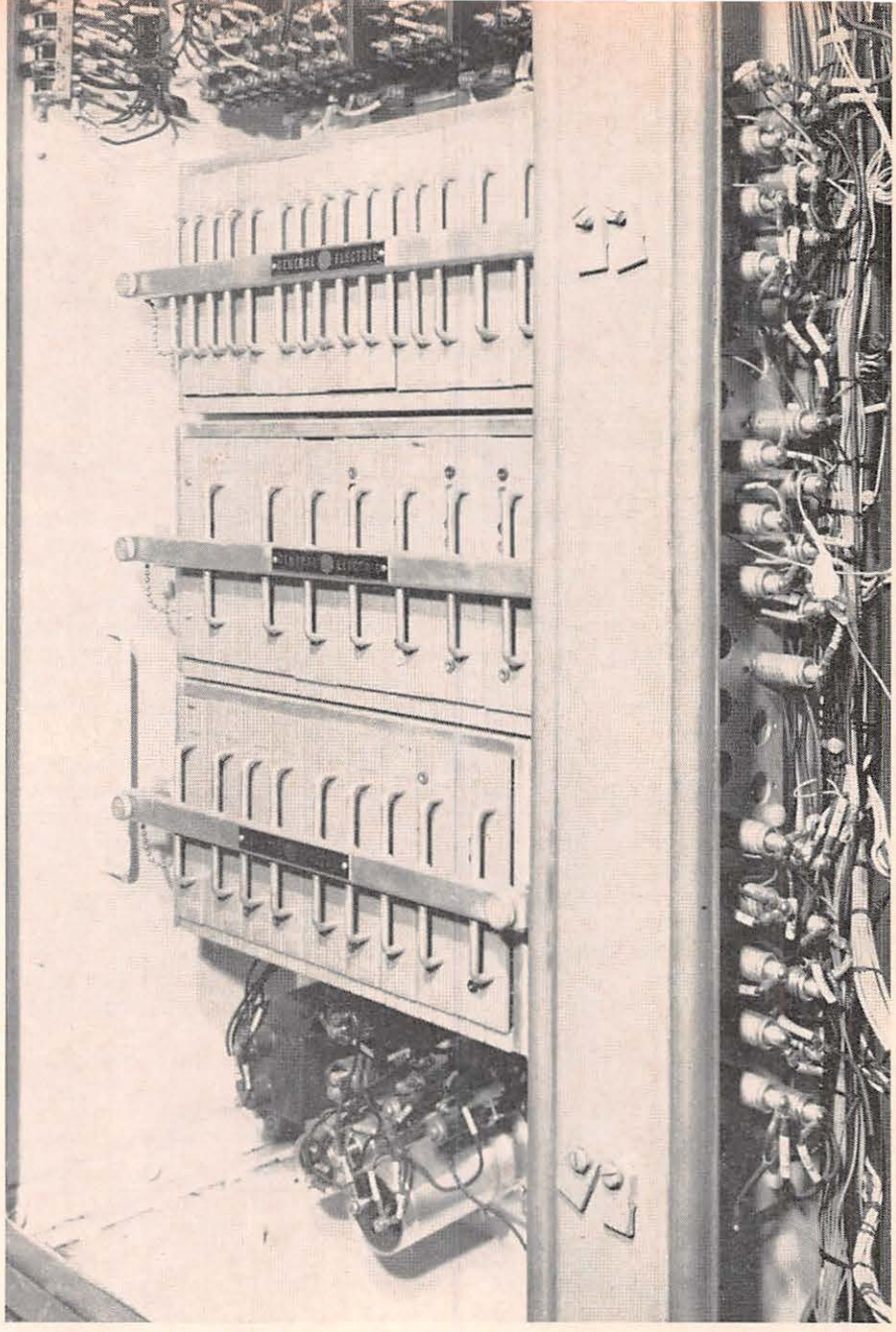
Once a speed command has been received on board by the communications equipment and given to the speed regulator, the corresponding relay is picked up which provides the reference voltage for that speed command. This voltage is seen as a step change into the speed reference generator which begins ramping toward the inverse of the input voltage at a rate determined by the potentiometer setting. The rate of acceleration is held constant by using a constant current source to charge the feedback capacitor. The integration stops when the output reaches the inverse of the input and this voltage becomes the regulating point for that speed command. An identical circuit provides an overspeed reference signal which remains slightly above the speed reference signal thus continuously providing an overspeed signal on all speed changes. Figure 2 shows the relation of the two reference signals and actual train velocity. Each speed command has its own speed and overspeed reference so each can be set precisely.

The outputs of the error amplifiers have a range of ±11 volts DC with +11 volts DC being a call for full motoring, zero volts coast, and −11 volts DC full braking. A selector chooses either the "hi" or "lo" speed error amplifier output depending on the speed command and feeds this output to the 0/22 volt-DC translator which converts the ±11 volt-DC analog signal into a positive 0 to 22 volt-DC signal.

The 0/22 volt-DC translator design is also based on the "fail safe" principal where any component that is shorted or opened will not cause the output to be more permissive than the input allows. The circuit takes the DC input, chops it at 5 KHz, shifts the level by 11 volts, amplifies the signal, feeds the AC into a transformer for isolation, and then rectifies and filters it to provide the 0 to 22 volt-DC signal. Thyristor phase control of motor current in both motoring and dynamic braking is regulated by the translator analog signal. Analog-to-digital conversion circuits switch the propulsion control between motoring, coast, and braking, and as increasing amounts of retardation are required, call for train air brakes and locomotive independent air brakes.

Figure 3 shows the relationship between the 0 to 22 volt-DC signal and motoring or braking. Above 12 volts the locomotive is in motoring. From 11.0 to 12 volts is the coast mode. Below 11 volts inshot is applied and dynamic braking comes on at about 9 volts going to full dynamic braking effort at about 5 volts. If this braking effort is still not sufficient to slow the train, the train brakes are applied at 4 volts, which reduces the brake pipe at a controlled rate of about 1 to 2 pounds per second.

The ATO equipment also contains other protective circuits for safety in operation of the train. To protect the motors from having current on them and the locomotive not moving, a timing circuit is energized when the ATO motoring relay picks up and times out in 30 seconds if two things have not happened. They are: locomotive and train brakes must be released and the no-motion relay must have dropped out. When these two things occur, we are reasonably certain that the motors do not have power to them while the



Transceiver units are mounted in short hood of locomotive.

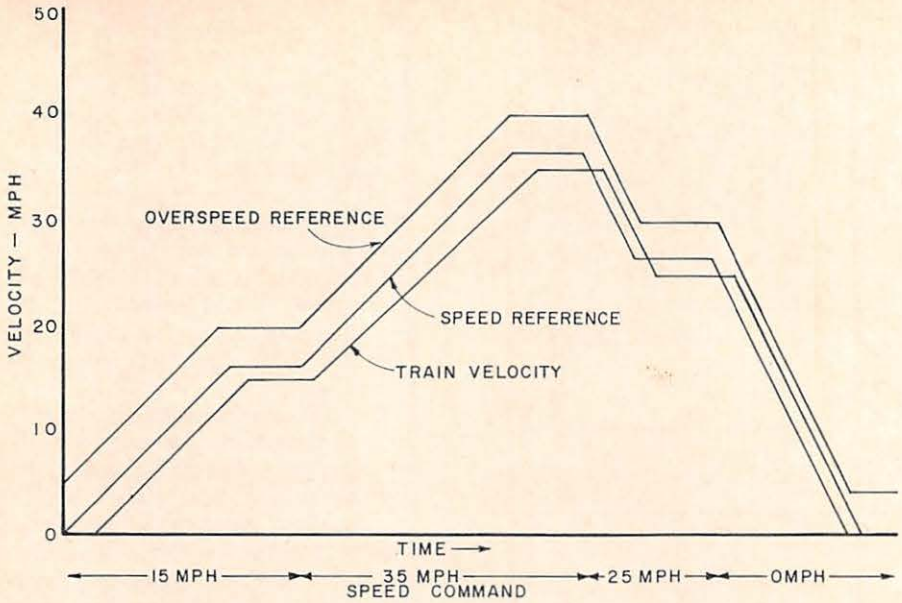


Figure 2—Relationship of velocity to the two reference generators.

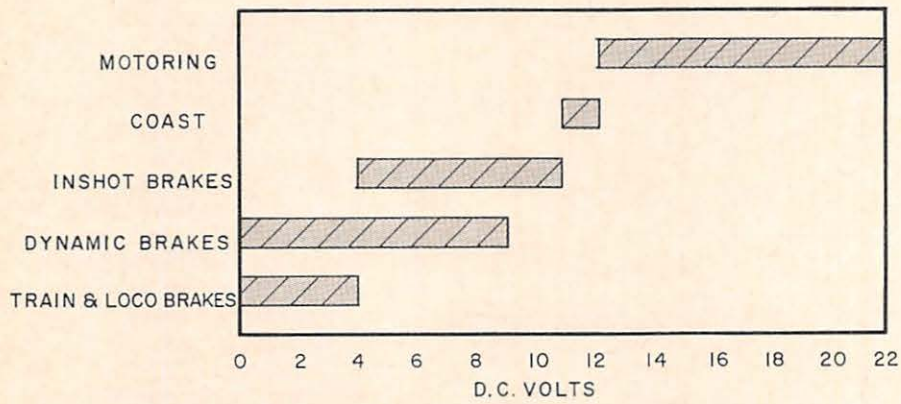


Figure 3—Motoring, coast and braking relationship to analog error signal.

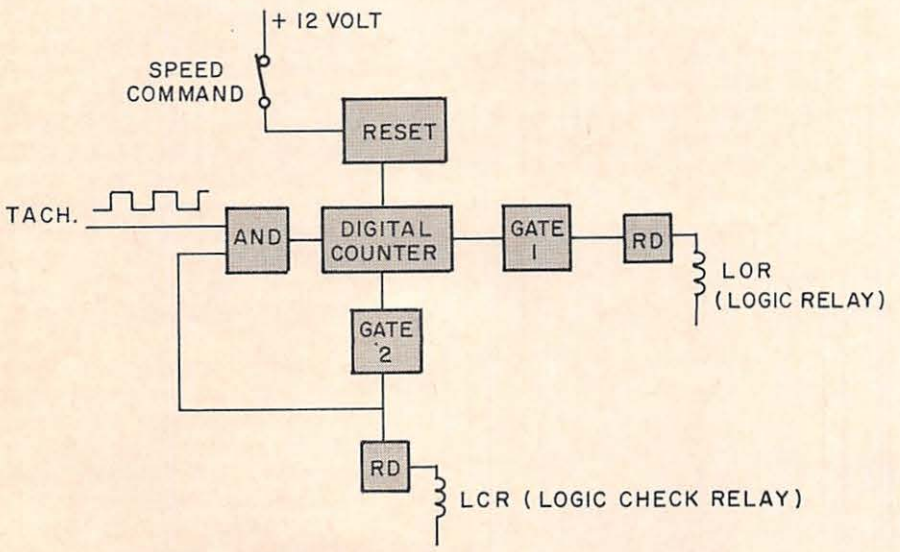


Figure 4—Block diagram of distance monitoring logic circuitry.

locomotive is standing still.

The locomotive horn is used as a warning signal when the locomotive enters the loading and unloading zones. The final speed command on the mainline is a zero which triggers the horn circuit which blows the horn for 5 seconds and then is off for 15 seconds. It continues this for about 5 minutes until a timing relay drops out. The locomotive bell is also sounded as a safety device and rings as long as the locomotive is moving.

Two methods of communication are used to receive speed commands on board, continuous in the loading and unloading area and intermittent on the mainline. The continuous system uses 200 KHz carrier current to communicate with the locomotives. The onboard receiver discriminates the low frequency tones which are then filtered to drive individual command relays. Commands used are zero, creep, 4, 15, 35, and 50 mph, north direction and south direction.

The intermittent communication system provides 25, 35, and 50 mph commands corresponding to the speed restriction on the mainline and a stop command located at each end of the intermittent zone to stop the locomotive in the event the continuous system is off the air. Once the locomotive is in the continuous zone, the zero command from the intermittent is overridden by the continuous command.

The intermittent communications equipment uses API (Approach Position Indicator) units spaced in pairs about 4,000 ft. apart. Receipt of a speed command starts a counter which "counts out" the distance between pairs of API units. The logic circuitry is shown in Figure 4. The counter is a binary type made up of 14 flip flops which count pulses from one of the MM24 tachometers. The counter is programmed to "count out" shortly before reaching the second pair of API units. Gate 1 triggers at 7680 counts and drops out relay LOR which clears the ATO of any speed command memory and resets the counter so it is ready to "count out" again when the next pair of API units is passed. If for some reason the counter does not clear the speed command by dropping LOR, it will continue to count until gate 2 is triggered dropping LCR to trip ATCR and lock up the counter.

The ATO equipment receives two momentary contact closures each time an API unit is passed over. One contact closure is for the speed command coded in that API and the other contact closure is present for all API units and is used to set up the timing sequence shown in Figure 5.

As previously described in the dis-

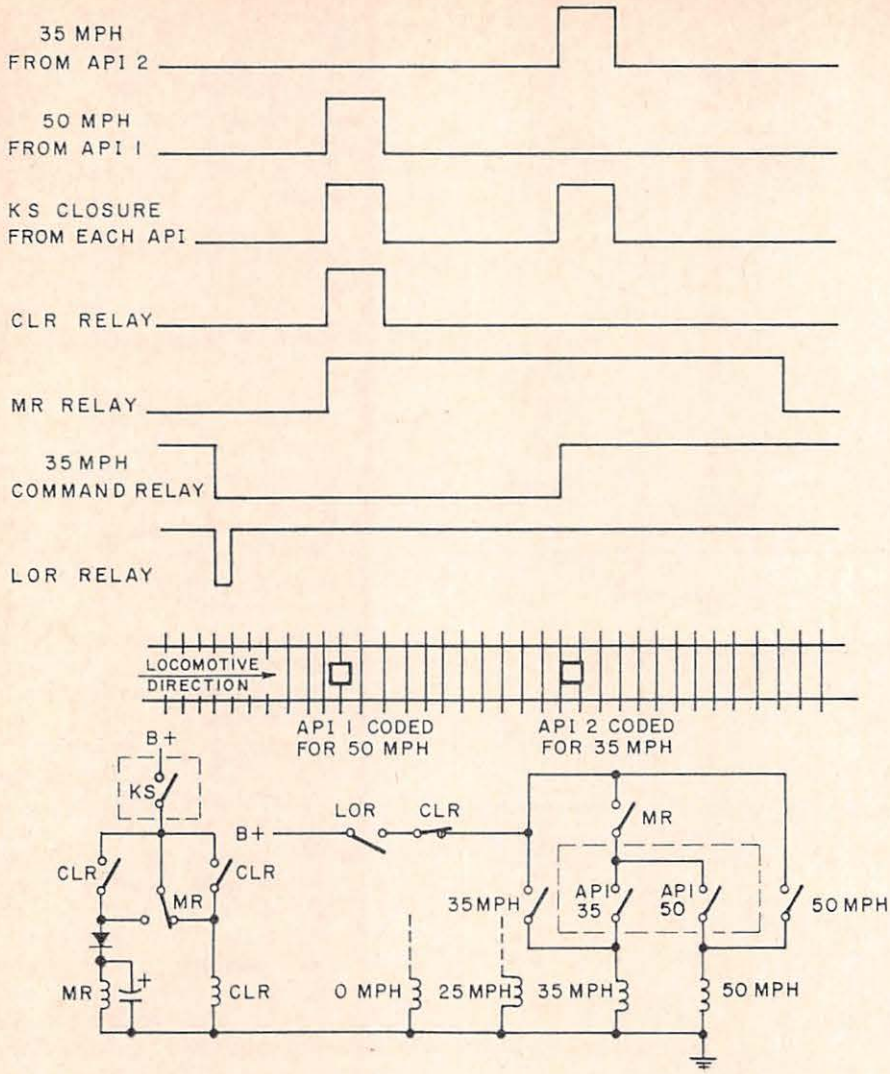
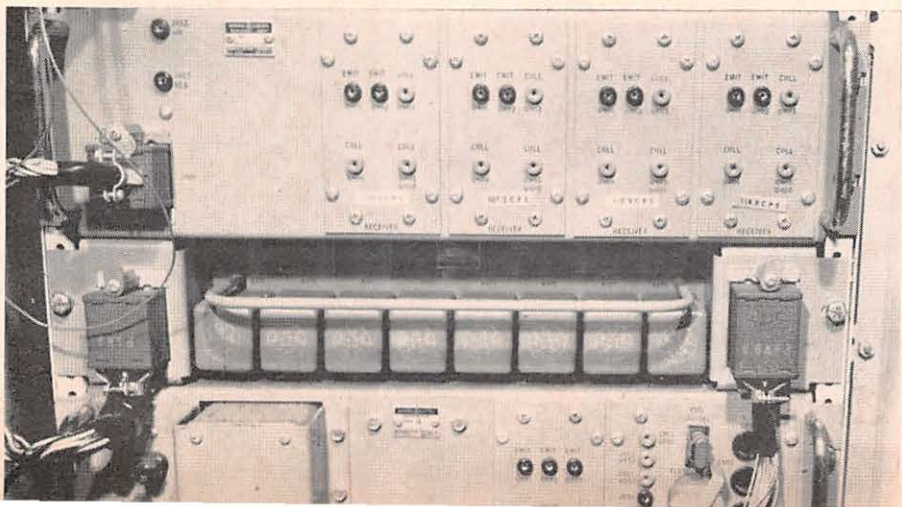


Figure 5—Timing sequence for intermittent commands. (Below—onboard units)

tance monitor, LOR drops out shortly before the first API is reached and drops out the 35 mph command relay. This puts a no command on the locomotive until a new command is received from the next pair of API units. In the event one or both of the next API units is missing or does not work, the locomotive will stop on the no command which is the same as zero command.

In this illustration the first API is coded for 50 mph. As the locomotive passes over it, the 50 and KS contacts close momentarily. This picks up the ATO CLR (Clear Relay) and MR (Memory Relay) relays. CLR picks up so the 50 mph will not seal in. MR is time delayed for about 3 seconds so the next API must be passed before MR times out. As the second API (coded for 35) is passed CLR has dropped out and MR is still picked up so the ATO 35 mph command relay picks up and seals itself in. This places a 35 command back into the speed regulator and also starts the distance monitor counting again. During the time there is no command into the regulator, power is not removed from the locomotive because of the low deceleration rate programmed into the speed reference generator. When the locomotive travels in the opposite direction, the 50 mph command is memorized rather than the 35 mph command. Using this method of setting up the relay logic with the first API, the ATO only recognizes the information in the second API. This permits programming of speed commands in both directions independent of each other.



The ATO equipment is designed for the safe operation of these locomotives by using the "fail safe" design philosophy for use in vital circuits as well as providing checking circuits which monitor portions of the equipment to insure they are still operating properly. The speed maintaining is done on the closed loop principal where a velocity error signal is generated from the difference between a speed reference and actual train velocity. The ATO also provides other protective circuits as well as warning signals in the loading and unloading areas.

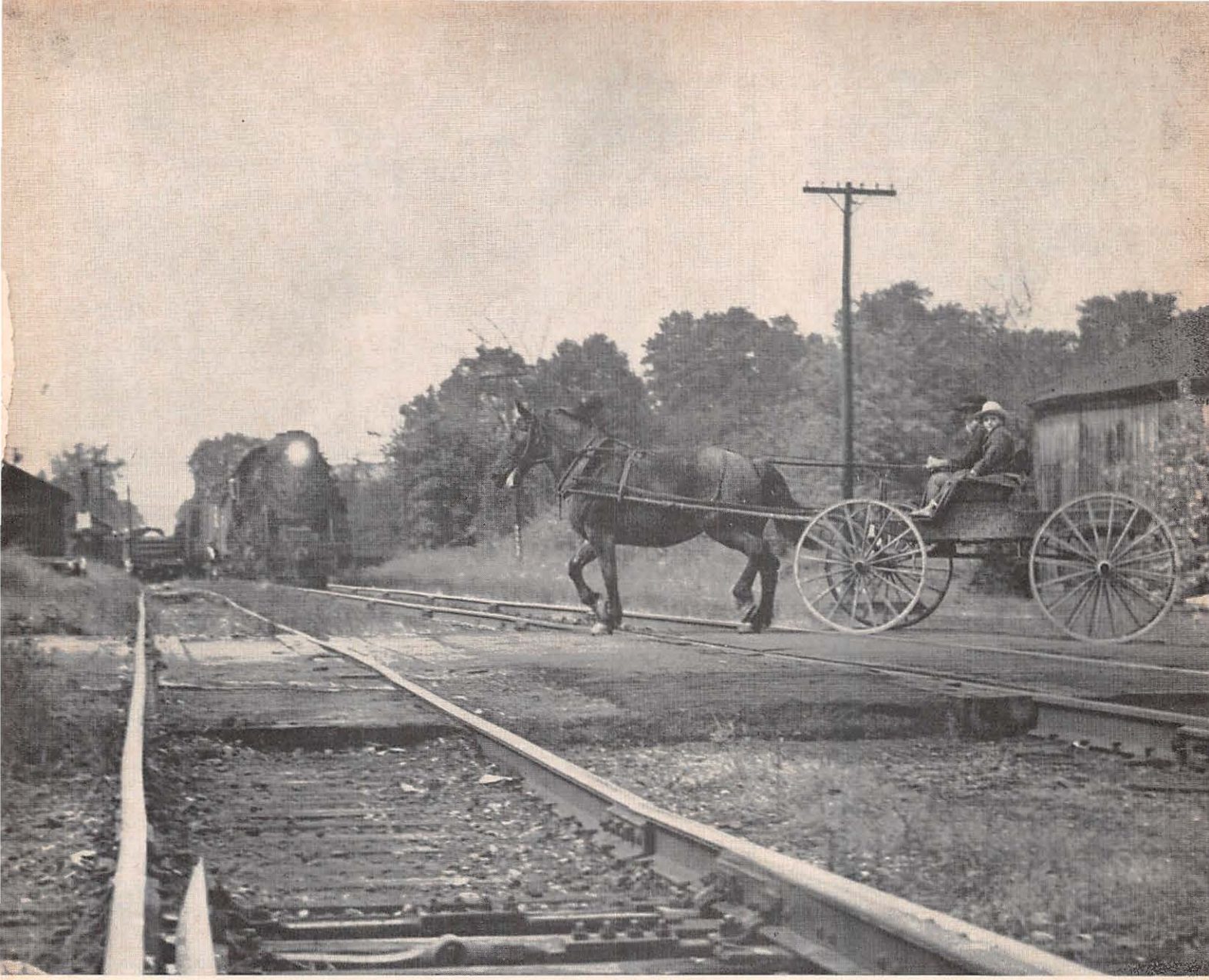
General Electric's rail haulage automation system, described in this series of articles, is the first fully automated system in the United States providing crewless train operation.

The unique technologies that have been successfully applied to this automation system for the Muskingum Electric Railroad provide the tools that are required by the railroad industry for future automation.

The pioneering use of Approach Position Indicators (API) for wayside communication intelligence permits automated operation in even the remotest areas without the necessity of electrical power. A totally new use of proximity switches for train location identification has resulted from the automatic loading/unloading and train separation requirements imposed by the MERR.

And, in still another area, technological spinoff from General Electric's transit equipment has resulted in the application of a highly reliable speed regulation system for the MERR. This system, which receives speed commands from the wayside, is operating in daily revenue service on America's only automated transit line (Port Authority Transit Corporation's line from downtown Philadelphia to Lindenwold, N.J.)

Of particular importance is the fact that all rail automation principles and technologies discussed in this series of articles in conjunction with the Muskingum Electric Railroad are applicable to any locomotive—be it straight electric, diesel-electric or diesel-hydraulic—in any railroad operation—mainline, industrial or mining.



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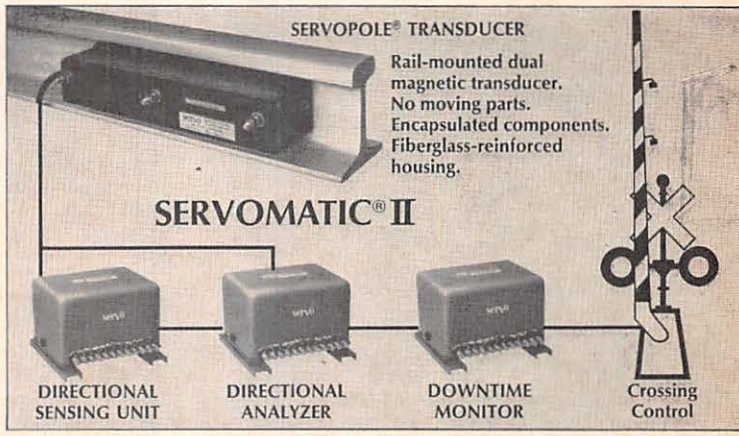

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MEMBER RPI

(Continued from page 21)

way of grounding the equipment housings," Bolton said.

Editor's Note: Essentially the full text of Bolton's paper will be published beginning next month.

Hotbox Detectors

Canadian National has 70 hotbox detectors in service spaced 32-35 miles apart along mainlines. Although normal practice is to stop trains when the tape readout shows a differential reading of 8 mm or more, CN has experienced hot friction bearings at readings as low as 4 mm. Workload of dispatchers reading tapes could be cut 30% if an event marker was used to indicate the suspected journal on the tape, and this event marker could be coupled to an audible alarm. So stated Donald H. Green, engineer of signals, CN, who moderated a panel discussion on hotbox detectors.

There is a need, he said, to separate friction from roller bearings when reading tapes. Tests on CN's mountain region indicated that friction bearings did get hot when the tape indicated only a 2-3 mm differential deflection on the same axle. On the other hand, trains are stopped if cars equipped with roller bearings show an absolute deflection of 12 mm or more.

For the high-speed, high-density of traffic line between Toronto and Montreal, CN is installing 22 hotbox detectors, spaced about 20 miles apart. This closer spacing (compared to 35 miles on other CN lines) says Green, allows them to let a car with a warm journal go and observe its perfromance after passing a second detector. It's a case of judgement, but with closer spacing of detectors, there is less risk in letting a car with a warm journal pass another detector to be sure it is heating up to become a hot one.

To keep the dispatcher at Belleville from being inundated with paper tape from 22 hotbox detectors, only 8 recorders were installed. A switching system selects recorders in random sequence. Studies of traffic and past history of hotbox occurrences indicated that 7 recorders plus one spare would be sufficient to handle detector outputs. An audible alarm sounds and a lamp is lighted to alert the dispatcher. Also, a two-digit number is displayed on the recorder front panel to identify the detector that has been actuated. An event recorder marks the paper tape where the hot journals are indicated.

Full or partial recording is available, reported Arthur J. Glazar, senior engineer, Servo Corp. To save paper, the recorder can be set to record only after the first alarm indication. Thus, if a train has no hotboxes, no record is made. When the recorder is set for partial recording, the heat signal from the detector is stored for 50 milliseconds to allow the tape to get up to speed. Forty-eight carrier channels are used for transmitting the detector indications to the Belleville dispatcher's office, Glazar said. RFL single sideband line carrier equipment is used along with the Servo carrier units.

Southern Railway has 153 hotbox detectors in service. Of these, 98 are line-of-road detectors from which detections are recorded at a central office in Atlanta, Ga. Here, experienced personnel read the tapes. As many as 10-12 recorders could be running simultaneously. Approximately 1100 tapes per day are recorded in this detection office.

A tape is recorded for each train passing a hotbox detector, said R. A. Howell, senior communications engineer, SOU. The alarm system is used as an aid to the operators by indicating which recorder tape has the overheated journal indication. If there is an overload of work, more operators are assigned. Skill in reading and interpreting the tapes is acquired from experience, and said Howell, has paid off more than once when an operator radioed a train to stop, although the pip height on the tape was not high enough to alarm. Operators will compare two or more tapes on the same train to determine if some suspicious looking journals are heating up.

Southern calibrated detectors with a heat source to obtain 18 mm deflections at 90 deg above ambient temperature for line-of-road detectors and 18 mm deflection at 100 deg above ambient for yard approach detectors. These yard approach detectors are closer to yards than the approximately 30 miles spacing of the line-of-road detectors. Yard approach detector readout is in the car foreman's office.

There have been instances, Howell said, where a roller bearing on a car had an absolute deflection of 25 mm but other journals on the car produced only a 10 mm deflection with a temperature of 125 deg above ambient. Normally, trains are stopped when the pip height on the recording tape reaches 18 mm. However, some cars were found with hot journals and indicated only 12 mm deflection. Such cases are found by the experienced personnel reading the tapes and watching for journals that show a history of increasing heat as they pass successive detectors.

Western Pacific experience with hotbox detectors indicated that the normal 8 mm differential deflection used to stop trains for hotboxes is not always sufficient to catch overheated journals. Following pyrometer measurements on both roller and friction bearings, WP signal engineers with the aid of Noller Control Systems, developed a ratio comparator alarm system.

According to B. L. McNeill, Jr., engineer communications and signals, WP, the alarm system operates if the ratio of the hot end of the axle to the cold end is at least 3. From the five hotbox detector installations, indications are sent via Lenkurt 960A hot journal carrier system to the dispatcher's office in Sacramento, Calif. An event marker pen is actuated to indicate the hot journal.

WP uses a wayside indicator that shows a steady white "H" on a black background. If no hotbox is detected, the indicator clears to a flashing aspect allowing the train to proceed.

HBD DISCUSSION

The full tape recording from a hotbox detector can be an aid in preventive maintenance, said R. D. Liggett, chief engineer communications and signals, Seaboard Coast Line. Also, such a record is most helpful in case of a derailment.

Some railroads have had cases of hotboxes at both ends of the same axle. Here is where examination of the tape is most useful. N. C. Pace, assistant to vice-president, communications, SOU, said that about 30% of the cars stopped on his road have roller bearings, and approximately 75% of these are found to be all right.

WHERE THE ACTION IS

"Participate and communicate," was chairman H. R. Beck's message to Communication & Signal Section members. At this ninth annual meeting, CN's assistant chief engineer—administration, issued a call for greater participation by railroad men in the annual meeting. With the widening activity of communications and signals, Beck said "get involved or be dissolved" and "innovate don't vegetate." Echoing keynote speaker Stephenson, Beck said that C&S men can contribute greatly to railway progress.

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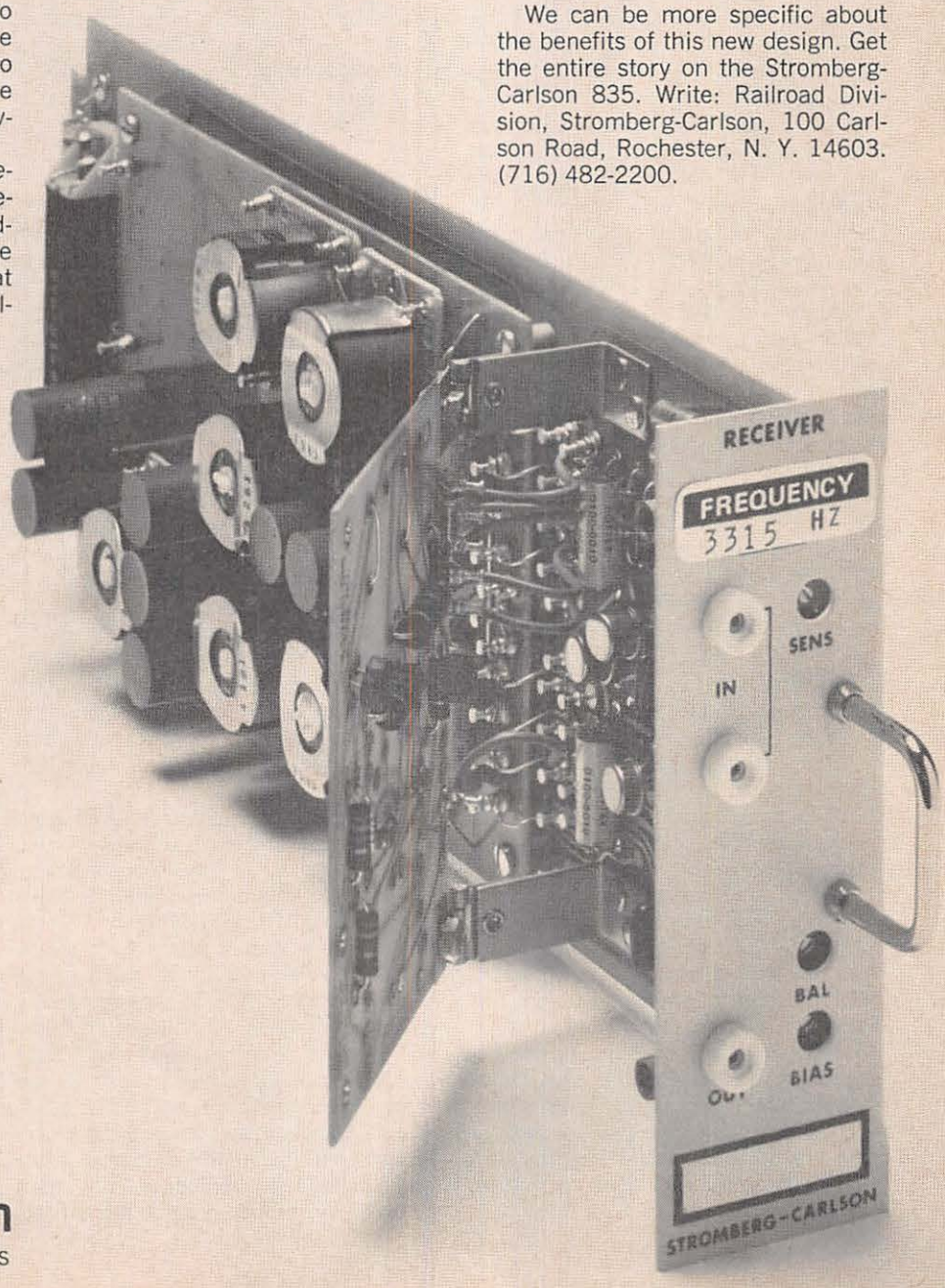

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Railway Cybernetics

ACI gets DSD attention

Automatic car identification, which admittedly has had growing pains, was given a soul-searching look by interested railroad men at a Data Systems Division workshop. The session at the 5th annual DSD meeting in San Francisco did much to bury "old wives tales." ACI cuts across several departments and disciplines, which makes cooperation and coordination essential. ACI involves mechanical, signals and communications, operating and data processing departments.

Analysis and evaluation of total systems throughput—from label application to computer output of ACI based information—is essential said W. H. Thompson, vice-president operations and general manager, Illinois Central, who is chairman of DSD's Ad Hoc Committee on ACI. System logic and scanner operation have and are being perfected at satisfactory levels, but there are interface problems. Here is where communications and data people must work together.

Some positive evidence brought out at the workshop included the following:

—40% of car fleet labeled as of Aug. 15, 1969, which is probably half by now (roads are 45-60 days behind in reporting to DSD on labeling status).

—No railroad has less than 30% of its cars labeled.

—At least 10 railroads will have all their cars labeled by year end.

—Nine railroads have 31 ACI scanners in service. By the end of this year 50 ACI scanners will be in service.

—At least 200 scanners will be ordered during 1970.

—Duluth, Missabe & Iron Range with three 800 series scanners is achieving 99.87-100% accuracy. Missouri Pacific test with 5 scanners is obtaining 99.45% accuracy on cars labeled correctly.

—DSD ad hoc committee on ACI is going to recommend to the AAR board of directors that after Nov. 1, 1969 railroads which label foreign line cars or correct bad labels on foreign line cars be given two days' per diem reclaim on each car so labeled.

Also, the ad hoc committee is going to recommend that its scope be broadened from advising on use of ACI to include work on setting procedures and performance standards for scanners, decoders, interface equipment and communications systems. Emphasis will be on hardware functioning. To fully accomplish this, the committee is recommending expansion to include members from research department, AAR, mechanical division, communication & signal section, and operating-transportation division.

Tighten Control

The time has come, Thompson said, to tighten control of the freight car fleet. The funds are not going to be readily forthcoming for the easy solution to the freight car shortage, namely, buy more cars. Wage costs are rising faster than equipment costs.

One of the biggest problems ahead for many railroads is that of handling ACI data. Input/output programming and data processing techniques involving ACI-generated data must be developed. This is where communications and data processing people are going to have to work together.

Railroads have spent about $12.5 million for labeling cars. With that investment, railroads are going to make ACI a workable system, Thompson said. Complete and thorough economic studies and evaluations can show ACI paying its way.

Canadian National has 20 ACI scanners on order and each is being located at major yards or interchanges where the economics are very much in favor of installing ACI, said Peter B. Wilson, chief of operational research & industrial engineering, CN. On the basis of economics alone, CN is planning major ACI installations. Additionally, they will benefit in error reduction. Here too, Wilson said, it cost money to run down and correct errors. While reluctant to discuss open car records, it was brought out at the workshop that it is a problem of the dimension of about 2,000 or more open records per month. Conservative estimates put the cost of clearing these records at $10 each or some $20,000 per month.

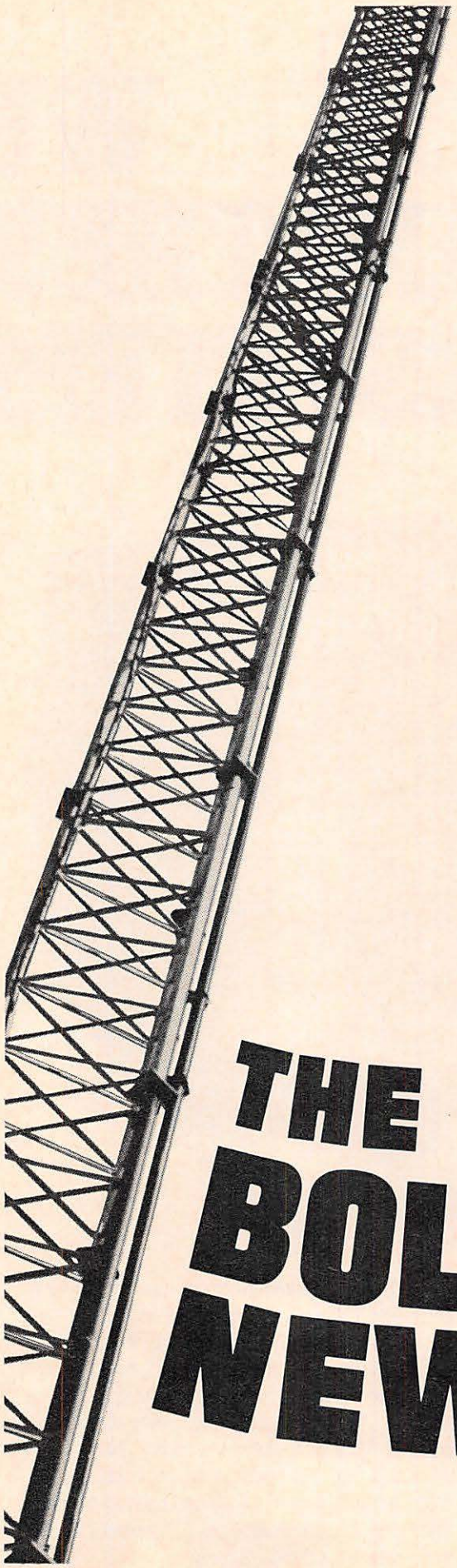
Canadian Pacific is going to install 11 ACI scanners at its new Alyth yard now under construction at Calgary. These scanners will feed directly into two Honeywell DDP516 computers controlling the yard. Nine scanners will be on yard approaches, one will be at the CN interchange and one ACI scanner will be at the hump. The yard will be in service in mid-1971, said Mac C. Norris, transportation engineer, CP.

Work has been completed by the ad hoc ACI committee on interfacing ACI with detectors. The committee is recommending to the DSD general committee that up to two alpha characters be printed opposite the car initial and number to indicate the type of defect detected. Defects noted include DE for dragging equipment, FL for broken flange, HB for hotbox, HW for oversize load and LW for loose wheel. Print outs will include an E, W, N or S to indicate side of car, said J. J. Schmidt, director of research services, C&O/B&O.

Also, the ad hoc committee has developed secondary label standards. Format control to read containers will be able to read secondary labels. They will be designated by a "5" after the start module. Nine codes will be used to indicate the type of secondary label: 01 is mechanical monitor; 02 is for route; 03 is train number designator; 04 is tare weight of the car; 05 is car classification; 06 is container data; 07 is status monitor; 08 is for exclusive use of the railroad owning the labeled car or locomotive; and 09 is a spare. These indicator digits are followed by six digits of information.

WABCO's licensed KarTrak ACI system is in production and installations will be in service shortly after the first of the year, said Paul E. Dunn, marketing engineer ACI, Signal & Communications division, WABCO. Incorporating in its basic system VC-1, is a wheel counting subsystem. Two wheel detectors are mounted on the rail with the

(Please turn to page 35)



At ROHN, we build towers from the sky down. No, we're not putting you on. This is just the way we look at it. It's what makes the bold new breed of men at ROHN so bold, and so new. We visualize the top section of your railroads microwave or other communication system tower first because that's the important part. The rest is just support —a means to an end.

Like we say, we visualize the top, then take the best possible way of attaching it to the ground. Best because we build all our towers from the finest raw materials available. We design and fabricate the parts, hot-dip galvanize them after fabrication, deliver them to your erection site if you like, and erect your towers for you. No, not from the sky down. Nobody erects them that way, but we think that way.

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Circle 16 on reader service card

WE ANOTHER IN INTERSYSTEM

Meet the new Lynch Data Sets. Available only through Graybar. They're fully compatible with the W. E. 100 series Data Sets including plug interchangeability. And the Lynch L2103A also has identical "test procedures" allowing it to be tested into the Bell System Data Test Centers.

Both the L2103A and the L2103F solid state Data Sets provide "narrow band", simultaneous two-way transmission of data at speeds up to 300 bits per second between customer-owned business machines and data processing equipment. They will transfer binary serial data between any two terminals of a voice-switched telecommunication system, using either the public access (DDD) network or private (leased) lines.

PRESENT BREAKTHROUGH COMMUNICATIONS.

Lynch Data Sets are easy to service because all solid-state components are mounted on printed circuit boards, to provide plug-in modularity. And screw switches are used for practically all adjustments.

They're packaged in attractive two-tone gray, high-impact plastic cabinets designed for desk-top operation. And they weigh only eight pounds.

Lynch Data Sets are just another example of how you can depend on Lynch when it comes to compatibility.

For fast, dependable service, for any communications problem, call Graybar. Specialists in communications, with local service in over 148 cities.

GraybaR

Circle 23 on reader service card

Data Modem Characteristics

Prepared by Leo J. Ritter Staff Engineer, Communications & Signals, Penn Central. Reprinted by permission of John McNabb, Engineer, Communication & Signal Section, AAR.

Manufacturer	Lenkurt Electric	Lenkurt Electric
Model	25A	26C
Transmit and/or receive	Transmit & receive	Transmit & receive
Full and/or Half Duplex	Full or half duplex	Full or half duplex
Dial up or Private Line Application	Dial or private line	Private line
Turn around time (HDX)	—	—
Automatic answer capability	No	No
Type modulation	Frequency shift	Frequency shift
Operating Frequencies	25 channels, 120 Hz spacing, 420-3000 Hz	1200 & 2400 Hz
Clock, internal or external	None	Either
Loop back testing feature	No	Yes
Error rate	—	Approx. 1 in 10^5
Error detection and/or correction	None	Detection at 2400 bps
EIA RS-232-B interface	Yes	Yes
Bit or character rate	120 Hz spacing, 75 bps	600, 1200, 2400 12000, or 24000 bps
Serial or parallel transmission	Serial	Serial
Impedance to line, ohms	600	300, 600 or 900
Impedance to data equipment, ohms	RS-232-B and others	Over 5000
Voltages to and from data equipment	RS-232-B	To ±20 volts DC
Frequency stability	±2 Hz at 120 & 170 Hz ±3 Hz at 340 Hz	1 in 10^4 or 1 in 10^8 per day
Level stability	—	—
Output levels to line, dbm	+6 to −40	+6 to −10
Input levels from line, dbm	−6 to −42	0 to −30
Line requirements, frequency response	Depends on number of channels	−2 to +6 db 900 and 2400 Hz
Line requirements, envelope delay	—	Within 1800 ms 700 to 2700 Hz
Line requirements, impedance	—	300, 600 or 900 at 1000 Hz
Line requirements, signal to steady noise	20 db	—
Line requirements, signal to impulse noise	—	4A voice grade
Method of operation	2 or 4 wire	4 wire
Temperature and humidity limits	0 to +50 deg. C 0 to 95%	0 to +50 deg. C 0 to 95%
Power requirements	−24 or −48 volts DC 115 volts AC	24 or 48 volts DC 117 volts AC
Dimensions and weight	5.25" on 19" rack	3.5" x 19" x 10", 20 lb
Digital or analog	Digital	Digital

(Continued from page 30)

scanner beam approximately at the mid-point between the two wheel detectors. Pulses from the wheel detectors are accumulated in a pair of electronic counters. Utilizing the train track circuit inputs and utilizing the direction information provided by the contents of these counters, various logical decisions are made to initially determine the number of axles on the first truck of a passing car. Once the number of axles on this truck has been correctly ascertained as 2, 3, or 4, the contents of the counters continue to be updated as the wheels on the second truck pass.

After this truck has passed, end-of-car signals reset the counters as required in preparation for the next car. By these means, the wheel counting subsystem accounts for each passing car. Therefore, for cars having no rolling stock label, the correct number of no-label messages is generated.

Decoder Options

WABCO is providing several decoder options, Dunn said. "In order to minimize the time required to transmit the ACI data on a communications channel, the total car count option will suppress the normal no-label messages from the ACI (the normal no-label message is a series of 12 zero characters for each unlabeled car). Realizing that some portion of the national car fleet is yet unlabeled (especially during initial test installations), transmission time costs can be reduced by not transmitting the normal no-label messages. The total car count option will provide the facility for:

"Counting the total number of cars on a train (which is the total of unlabeled cars and labeled cars).

"Inhibiting the normal output mechanism for the no-label zero characters.

"Outputting the accumulated total car count of the train at the end of the train. With this facility, the ACI output message will consist of (a) message generator 'beginning of train' characters; (b) the ACI labels which were read (both rolling stock and piggyback trailers); (c) the message generator "end of train" characters; and (d) the 3-digit total car count characters.

"This message, containing the essential label and total car count data, provides to the railroad a measure of the progress of their ACI labeling effort, a measure of the ACI reading performance and a conservation of communication channel time," Dunn said.

To supplement the standard ACI communications polled interface options of 83B, 85A and 1050, WABCO is developing control logic to permit ACI to function as a Burroughs TC-500 terminal. "The TC-500 interface will require that the ACI have the optional core buffer for storage of data until polled out. In accordance with TC-500 poll and select procedures, the ACI, when polled, will output up to 256 USASCII characters at a 1200 baud rate (asychronously) in TC-500 format. The system also features acknowledge/non-acknowledge operational mode for retransmission of bad blocks of data. In a sequence of poll and answer messages, the ACI, looking like a TC-500 terminal, effectively transfers its ACI data to the central polling computer," Dunn said.

"For installations where trains can start, stop and change direction in front of the scanner, the WABCO direction change tracking subsystem will be employed. This system is an extension of our basic wheel counting approach. However, directional wheel detectors are employed and a more sophisticated logic is required. This subsystem attempts to determine 2, 3 or 4 axle trucks, and it functions normally until a change-in-direction pulse sequence from the directional wheel detectors is sensed. Upon detection of this direction change, wheel pulses already counted into the system for a car are counted out for its return in the opposite direction. By making various logical decisions and performing various count in/count out procedures, the ACI attempts to remain in synchronization with the actual passage of wheels and attempts to maintain the correct current direction of car movement information. By including the current direction intelligence in its output message and by keeping in sync-with (that is, tracking) the train movement, the ACI output can precisely reflect the actual train movement behavior at the ACI site," Dunn said.

The DSD committee on systems and data equipment communications is preparing a specification on a new field input/output terminal. The device will be designed specifically to meet the railroad industry's requirements for a dependable family of field I/O terminals capable of continuous operation both on and off line for prolonged periods without maintenance, reported chairman A. E. Pew III, director data control, CB&Q.

The device will communicate externally in 8 level USASCII code. Should there be sufficient industry interest, the vendor should be capable of producing a 5-level Baudot code model of this device which would operate at speeds of at least up to 100 wpm.

"The manager must be able to communicate with computer specialists,

B. F. Biaggini, president, Southern Pacific, said: "the manager must be able to communicate with computer specialists."

which means, basically, that he must interpret company goals and work procedures to them. In turn, he must learn from these specialists about the kinds of information he can obtain from a computer, and he must gain a full appreciation of the capacity of the computer, a comprehension that these new systems are not merely auxiliaries to existing practices but are instruments which can help him to create totally new dimensions of management technology," said B. F. Biaggini, president, Southern Pacific in his keynote address to the Data Systems Division, AAR, meeting in San Francisco.

"The computer expert's concern must be as much with people—learning from their experience and finding ways to meet their needs—as with the technical aspects of the machine operation. The information to be produced should be the result of many studies in the field to determine from the users the information they will require. In every case, careful attention must be given to the requirements of the using department through consultation, participation and involvement," Biaggini said.

"It is important here to stress the need for interdepartmental participa-

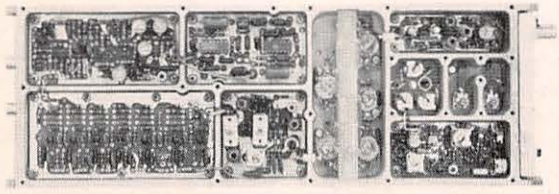
(Please turn to page 37)

Five channels 960 MHz

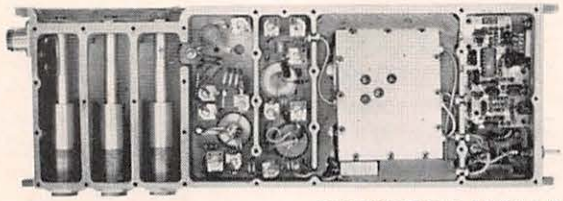
For the 790 to 960-MHz band, Granger Associates introduces a new solid state microwave transmitter/receiver terminal. The G/A Model 6010 provides five full channels plus optional order wire in a small, rugged package. The complete terminal including power supply takes just 5¼ inches in standard 19-inch rack.

The new Granger microwave terminals are made for telephone circuits, railroad work, unattended repeater stations, supervisory control and telemetering.

The January 1, 1970 FCC deadline is coming ... let us help you be ready.



RECEIVER MODULE



TRANSMITTER MODULE

Granger Associates / GRANGER COMMUNICATION SYSTEMS DIVISION

1601 CALIFORNIA AVE., PALO ALTO, CALIFORNIA 94304

Circle 18 on reader service card

Letters to the Editor

Dear Editor:

Our signal maintainer, F. Robins, whose territory includes from Welland to Smithville, Ont., was having quite a lot of trouble at one of the cut sections at which location track batteries were located in a concrete battery well. The trouble was that someone in the past two years was continually cutting the chain or the lock and was stealing the Exide storage batteries. In fact, in one or two instances, he returned two storage batteries, placing them in the section shanty located approximately ¾ of a mile from the battery well, and they were not even the same type that we use on the TH&B.

F. Robins, our signal maintainer, decided that he would write a note (contents of which he has not divulged to me) and place it in the battery well. On Thursday, July 4th, the lock was sawed into again and the test straps to the battery were opened, but he had not stolen the batteries. Instead, he left a note (printed below).

John R. Ragsdale, Signal Engineer, Toronto, Hamilton & Buffalo

The Thief: I am enclosing this money as a token of payment to you for the damage to your property. [Enclosed was a $10 bill.]

Thursday, July 4th, 1969—3:15 pm: To the railway men or railroad police officer in charge: At 3:15 pm I came to this underground box to steal the Exide batteries from it. After sawing through the lock with a hacksaw, I lifted the lid off and noticed that someone had left a note for me. Upon reading the note I felt a great feeling of guilt come over me. I also felt very sorry for the person who wrote me the note. Then I decided NOT to steal the batteries from the box or to take anything else that is NOT mine. I am truly sorry for my acts of theft, and I BEG your forgiveness.

What it is that makes me want to steal from others I cannot understand. These batteries seem to fill a deep void in my life that nothing else will. There is only one and NO more involved in these thefts. Again, I say I am very sorry for stealing your batteries, and I will not come around to steal any more from your railways. I am sorry for any inconvenience that I have caused you and I sincerely hope this will make it easy for you, the person who wrote me the note. May God bless you.

I will return the other two batteries I still have, later on.

Signed, the Thief

Railway System Controls

(Continued from page 35)

tion. The development of an information system cuts across department lines, since the communications network of an organization is determined by who needs what kind of information and not by who tells whom what to do. This fact must be recognized early and responsible people assigned from each department.

"The factors that make up total management involvement are: First, we have an interdepartmental group of individuals who can approve, determine, influence or supervise a given project. Second, we carefully select a senior member of the group and make him responsible for the project. Third, we tell him that he must know enough about the details of the project so as to be held accountable for all policy decisions, strategies and results of the project. And fourth, . . . if top management expects its people to spend time working on the development of new systems, it must provide the means to spread the workload so individuals are able to devote sufficient time to the project.

"We are talking about involvement, not consultation or participation. Management can participate in the development of a new system without being involved. Management can be consulted on the development of a new system without being involved. But management cannot be involved in the development of a new system without getting involved. And getting involved means spending sufficient time and effort to know not only the objectives of the project, but also how those objectives will be met. This, I believe, can best be done by having upper management in a user department responsible for the project. It seems to me that the best computer projects are managed by men experienced in the company's general operations as well as in computer systems, and who are knowledgeable about what is required to make the business profitable," Biaggini said.

"Today management will use a good system. Today, I believe, the technicians realize that a large part of their job centers around getting and keeping management involved and motivated. This means working with management from the very beginning of the concept stages through the final implementation of a project. It means working for the initiation of the proper organizational structure. It means placing the responsibility for the project in the area which will derive the greatest benefit, the user department," Biaggini said.

"There are other important things the technician can do to help assure the success of a new system. He can work for the removal of any remaining barriers of communicaton between his group and the users of computer-generated information. He can actively solicit management's participation by identifying the relevance of the new computer systems to the basic objectives of the user department.

"He should do a great deal of soul-searching about the relationship of the technician to the project. He has to realize that except for occasional program maintenance, he will not be associated with any of these projects on a long-term basis. They are being designed for someone else, and he is to move on to other projects with even greater challenges. Although he should take pride in the efficiency and design of the system, he must recognize that the new system, if it is to deserve to be called a success, must meet the needs of the user," Biaggini concluded.

Management will use good MIS systems

On how to motivate managers to use management information systems, E. R. Craven, general superintendent transportation, Burlington Lines, said: "I believe the most important phase is to apprise the manager of how the various systems will benefit him directly. We cannot overlook the corporate goal, but more benefits will be derived if the individual can see how this will improve his own operation.

"Individuals are motivated primarily in terms of their own particular needs and desires. No one likes to do an inferior job but quite often, for reasons beyond his control, that is the result. The best manager is one who manages himself and who incorporates this attitude in his subordinates. People are motivated by needs of their own to a much greater extent than they are motivated by pressures that management can bring to bear. The industry that manages motivation and change will be the one that attains the results that we are all after.

"We find a good deal of orthodox management procedures has a positive impact upon the individual's desire to handle a job properly. Sound salary and benefit programs, sensitive and appropriate supervisory methods, good two-way communication and procedures for recognition and promotion are all examples of traditional ways of motivating employees," said Craven.

"It is ironic that the very technology which demands increasingly sophisticated management to adequately direct it also tends to breed management obsolescence because of the rapid changes it fosters," said M. M. Christy, president, Western Pacific.

"Nowadays, every manager must expect to continue his education for the rest of his life. No longer applicable is the old truism that experience is the best teacher. An on-the-job approach is simply too slow. Technological advancement alone makes much of yesterday's know-how irrelevant to today's problems and opportunities. . . .

"Very closely allied to continuing education are other steps which will minimize the individual obsolescence risk. One is a questioning approach to your duties and the assumptions you make. Another is the deliberate widening of horizons by seeking new and varied experiences, both on and off the job . . . I finally suggest we all need to take some time each day to break our routine and think about the value of what we are doing and how we are spending our time. Essential to the success of these individual preventative measures is the creation by the company of an organizational climate in which obsolescence finds it difficult to flourish. This means a system which permits, encourages and hopefully forces flexibility and adaptive innovation," Christy said.

"Above all, our jobs should be designed to have meaning as related to the company's progress. Probably the most effective device in combatting the threat of obsolescence is to provide the challenge of problem solving, and the excitement generated by the purposeful pursuit of demanding goals. We must arrange for wide participation in the company planning and goal setting process, encouraging the exercise of as much individual ingenuity and creativity as overall goals will permit. This means downward delegation of decision making wherever possible.

"All this job enlargement or job enrichment or whatever you will, is but really the release of latent capabilities which in many people are unbelievable. Only in a company climate of this nature can individuals mature to their fullest dimensions, thereby contributing the maximum to themselves, to the enterprise and ultimately to society as well. When we have approached this stage of organizational and managerial development, most of the problem of obsolescence will have been solved," Christy concluded.

Data Modem Characteristics

Prepared by Leo J. Ritter Staff Engineer, Communications & Signals, Penn Central. Reprinted by permission of John McNabb, Engineer, Communication & Signal Section, AAR.

Manufacturer	Stromberg-Carlson	Stromberg-Carlson
Model	SC-301	SC-302
Transmit and/or receive	Transmit & receive	Transmit & receive
Full and/or Half Duplex	Full or half duplex	Full or half duplex
Dial up or Private Line Application	Private line	Private line
Turn around time (HDX)	—	—
Automatic answer capability	No	No
Type modulation	AM vestigial sideband	—
Operating Frequencies	—	375-3000 Hz
Clock, internal or external	Internal	Internal or external
Loop back testing feature	—	—
Error rate	—	1×10^{-5} or better
Error detection and/or correction	None	None
EIA RS-232-B interface	—	—
Bit or character rate	2900 bits/sec	75, 150, 300, 600, 1200 or 2400 bits/sec
Serial or parallel transmission	Serial	Serial
Impedance to line, ohms	600	600
Impedance to data equipment, ohms	Dem. 820; Mod. 10,000	—
Voltages to and from data equipment	—	—
Frequency stability	—	—
Level stability	—	—
Output levels to line, dbm	+4	0
Input levels from line, dbm	−35 to +5	—
Line requirements, frequency response	Voice Grade	HF voice channel
Line requirements, envelope delay	Voice Grade	HF voice channel
Line requirements, impedance	Voice Grade	HF voice channel
Line requirements, signal to steady noise	Voice Grade	HF voice channel
Line requirements, signal to impulse noise	Voice Grade	HF voice channel
Method of operation	—	2 wire
Temperature and humidity limits	50 to 100 deg F	—
Power requirements	117 volts AC	117 volts AC
Dimensions and weight	21½" x 9½" x 18½", 50 lb	—
Digital or analog	Digital	Digital

View from the Crossarm

• Some of us attending the Communication & Signal Section, AAR, meeting in Montreal had the opportunity of visiting one of Canadian National's signal training classrooms. It was equipped with completely wired and operative flashing-light signal, semaphore and colorlight signal, switch machine, electric lock, etc. Students not only can see what is shown on circuit plans in real life, but they can also learn how to shoot trouble.

CN has five such classrooms, one for each region: Atlantic at Moncton, N.B.; St. Lawrence at Montreal, Que.; Great Lakes at Toronto, Ont.; Prairie at Winnipeg, Man.; and Mountain at Edmonton, Alta. Each region has one signal instructor with two each at Toronto and Montreal.

Approximately 300-400 signalmen are in training. The basic course, Section 1 is required of all new signal employees. Section 1 covers electricity, signal apparatus, signal circuits and systems, organization and personnel. Section 1 covers two years and includes classroom instruction with lectures, small group discussions, practical demonstrations and films. Home study by correspondence is carried out between classroom instruction. Four courses of 10 days duration are given every 6 months. Students are sent to the classroom of their region with travel and living expenses paid by CN during these 10-day periods.

"One cheap C&S control system for one cheap customer."

Also, CN has advanced training courses covering fundamentals of electronics and advanced signal systems including detailed circuit operation.

• Cleveland Institute of Electronics exhibit booth at the C&S meeting contained many interesting examples of lessons and lesson plans. In the area of electricity and electronics, CIE can arrange most any combination of courses to fit railroad needs.

For example, a special course for technician apprentices of the Santa Fe consists of six parts:

I- 14 lessons, 6 months completion time, covers electronics including AC and DC principles, fundamental mathematics and amplifying devices.

II- 13 lessons, 6 months completion time, includes communication principles and applications as well as carrier theory and applications. Subjects include amplifiers, oscillators and operation of semiconductor devices.

III- 12 lessons, 6 months completion time, is a continuation of part II and covers modulation methods, detection and frequency conversion, measurements and carrier theory and applications.

IV- 13 lessons covering advanced communication theory and preparation for 2nd class FCC license examination. Subjects include antennas, transmitters, power sources, oscilloscope, installing, trouble-shooting and maintaining two-way radio equipment.

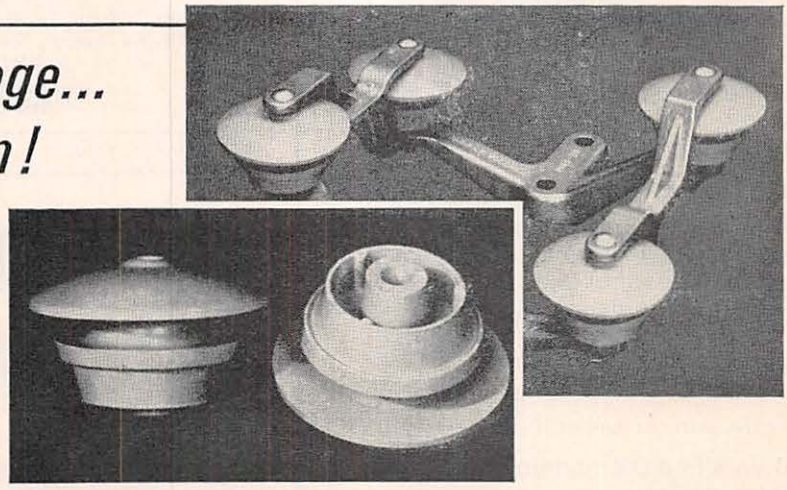
V- 8 lessons, 6 months completion time, covers microwave, higher mathematics, advanced trouble shooting techniques and transistor design.

VI- 8 lessons covering advanced theory, logic circuits and pulse processing.

Bob McKnight

Foil vandals, weather, age...
Get Better Insulation!

NEW TOPO T-15 FIBERGLASS INSULATORS



Good news for users of Case Transposition Brackets . . . New Topo T-15 Insulators are molded fiberglass — far stronger than glass against impact and tension stresses — far more durable than rubber against ageing, cracking, compression cutting by line wire.

T-15 Insulators will withstand rocks thrown by vandals —even light calibre bullets—without shattering. They won't shatter, explode, peel, or corrode from temperature extremes or weathering. Their volumetric resistance, double-petticoat design, and low surface conductivity make them more efficient electrical insulators than rubber in dry weather, than rubber or glass in wet weather. Tests by an independent laboratory confirm it — results available upon request.

Replace those vandal-broken and age-impaired insulators as they show up on inspection with Topo T-15's, and forget 'em. On new installations, specify T-15's for long-life savings and more effective insulation.

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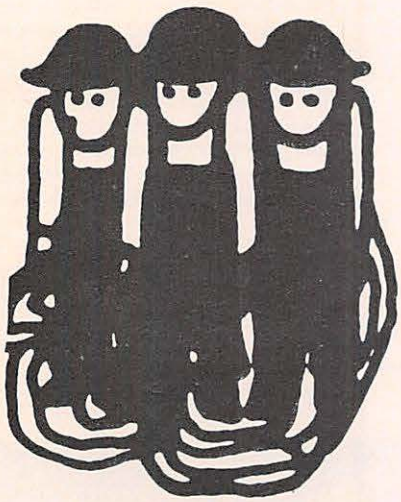
Circle 19 on reader service card

Now is the time to sell your obsolete line wire!



When plans call for going underground, a big part of the problem is up in the air. Diversified Dismantling Corporation, with its miles of experience in removing and salvaging communication wire and poles over every type of terrain and through congested neighborhoods, can take care of the problem for you and increase your salvage revenue.

Write, wire or call collect:

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Subsidiary of Diversified Metals Corporation
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Tamaqua, Pennsylvania
Liberty Smelting Works Ltd.,
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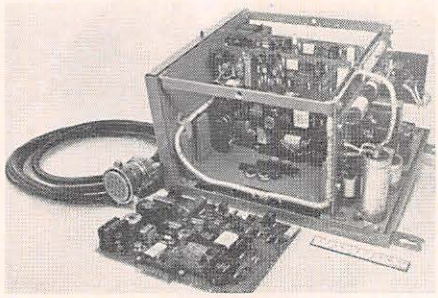
Circle 20 on reader service card

Product News



Impulse Track Circuit

An impulse track circuit features plug-in units for ease of installation, replacement and concentration of equipment. This equipment can be used in electrified and non-electric propulsion territory for track circuits about 3,200 ft long. French National Railways have used this high voltage impulse track circuit equipment for circuits about 16,400 ft long. *Jeumont-Schneider Circle 101 on Reader Service Card.*

● DATA SET: A data set capable of operating over private lines or the DDD network is described in a new bulletin. Transidata T202C transmits and receives asynchronous serial digital data over private lines at up to 1800 bps and over the DDD network at up to 1200 bps. User benefits highlighted in bulletin 5318 include end-to-end compatibility with all Western Electric 202 type data sets, and 801A and 801C automatic calling units. The bulletin also lists specifications, describes the functional operation of the sets, and contains illustrations. *Sangamo Electric Co., Circle 102 on Reader Service Card.*

Measurement System

A train length measurement system designated TLM, is an analog computer that measures the length of trains up to 9,990 ft. The TLM can accommodate trains up to 70 mph with variation of train speed

(Please turn to page 42)

Wanted—employment as C & S electronics engineer, six years railroad experience with eastern road. Please contact Mr. H. W. Pfeiffer, 52 Scotch Pine Drive, Voorheesville, New York 12186 for resume.

RAILWAY MAILING LISTS

Planning any direct mail campaigns to dramatize your products or services to the railway industry? Want to be right-on-target to *all* the buyers and specifiers . . . then write for our mailing list brochure that tells you how you can do it.

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ELECTRONICS ENGINEER

For permanent position in the Chief Engineer's Office, Montreal. Position will involve investigation and evaluation of new equipment; system feasibility studies; establishing installation and maintenance procedures related to the design and use of various types of electronic remote control and automation systems. Such systems may include carrier, telemetry, radio, digital and relay logic, process control computers, radar, etc.

The successful applicant will have 3-5 years experience in some of these types of industrial electronics. Railway experience will be an asset.

Salary commensurate with experience and qualifications.

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CANADIAN PACIFIC

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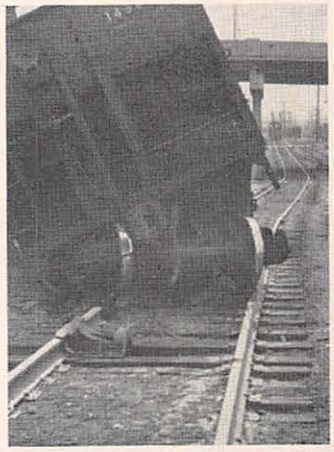

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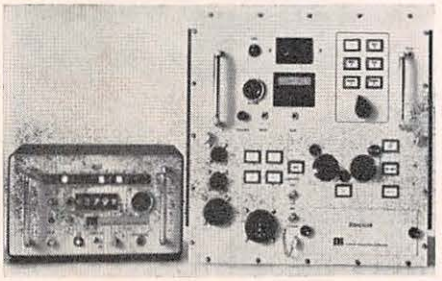
Circle 21 on reader service card

(Continued from page 40)

having no adverse affect on system accuracy.

TLM has two readout systems which measure train lengths in siding lengths, average car lengths, or in increments of 10 ft. The go/no go system may be interfaced with a CTC field unit to display up to nine selected siding lengths that a given train will fit into. The display will hold until a new train enters the circuit.

The direct readout system uses a digital meter to read out train length in feet or average car lengths (up to 180 cars) and holds this reading until a new train is ready to be measured. The meter can be located up to three miles from the TLM installation. *Marquardt Industrial Products Co. Circle 103 on Reader Service Card.*



Selective Calling

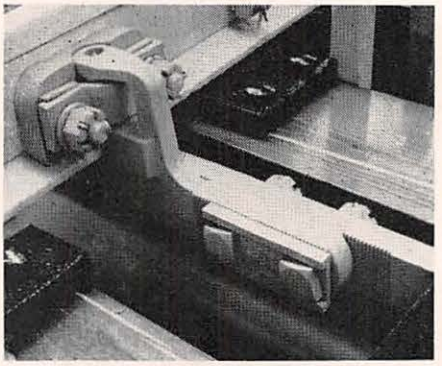
A selective calling system can be used with existing single and multi-channel communications systems for base-to-mobile and mobile-to-base operation. The system provides positive call establishment and identification in both directions while being highly resistant to false alarms.

The base station provides over 5,000 digital addresses and six pre-elected digital quick-access addresses. It digitally displays the channel used and the address of the mobile unit while providing audio and visual alarms. The mobi e stations incorporate push-button authentication plus audio and visual a'arms.

Solid state circuitry includes integrated circuits for high reliability and light weight. Digital selective calling systems are also available as "half-systems", base-to-mobile only. *Technical Communications Corp. Circle 104 on Reader Service Card.*

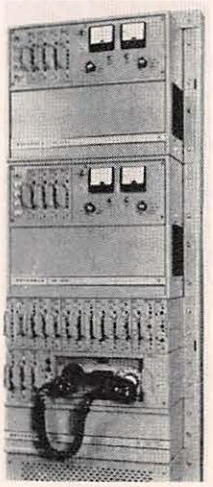
Data Set

A data set that transmits/receives asynchronous serial digital data over direct distance dialing (DDD) networks at rates from 0 to 1200 bps is Transidata T202D. This solid-state FM unit has end-to-end compatibility with Western Electric 202 series data sets, type 804A data auxiliary sets, and 801A & C automatic call units. Besides its DDD capabilities, the Transidata T202D functions at any rate up to 1800 bps over private communication channels. *Sangamo Electric Co. Circle 105 on Reader Service Card.*



Switch Rod Clip

A reversible clip for attaching MJ rods to switch points is the new SMJ clip. It is symmetrical, with serrations on both sides, and can be used for right or left-hand positions on the rods. Positive engagement of rod to the clips, assured by the meshing serrations, eliminates wear of the rod bolts and their corresponding holes. The fine adjustment permits accurate setting of the switch throw and also provides for identical rod assemblies being used in switch points of different lengths and occasionally of different rail sections, thus reducing inventory. *Railroad Products Group, Abex Corp. Circle 106 on Reader Service Card.*



Microwave

The new all solid state MR-300A series RF microwave equipment has 600 channel capability for present or future use of high speed data, facsimile, or video, and requires no RF equipment modification for full 600 channel capacity. The MR-300A solid state transmitter delivers one watt (30dBm) minimum at the antenna port, providing improved fade margins, better signal-to-noise ratio at the receiver, thus reducing the cost of the antenna system. The transmitter stability is ±0.005%.

The noise power ratio is 54db minimum for 600 channels, and levels used are compatible with CCIR recommendations. The primary power source is −24 volts DC or −48 volts DC, with optional power converters available for 120 volts AC or 240 volts AC. *Motorola Communications & Electronics Inc. Circle 107 on Reader Service Card.*

Improved Lamp

The apparent useful light output of flashing grade crossing signals has been improved 85% by adding a reflectorized surface to the lamp's glass envelope. This method of providing improved signal light intensity—with no increase in design current or voltage—collects the unused light emitted in the forward direction and reflects it back to a reflector in the light housing. Basically, the bulb's mirrored surface produces a secondary image of the filament just above the true filament. The resulting image acts as an additional filament projecting another beam below the axis of the main beam. *Chicago Miniature Lamp Works, Circle 108 on Reader Service Card.*

● TELEPRINTER, model SP-20, is an alphanumeric printer that weighs approximately 8.5 lb. This digital strip printer, which provides 64 ASCII standard, at 10 characters per inch, can provide printout rate at 20 characters per second. *Clary Corp. Circle 109 on Reader Service Card.*

● BATTERY/CHARGER of the automatic type is described in bulletin AG-800. Described is a complete line of automatic consoles housing both nickel cadmium battery and solid-state battery charger. *Nife Inc. Circle 110 on Reader Service Card.*

● RADIO of the two-way FM type is described in bulletin ECR-1479. The booklet describes the complete line of mobile radio equipment. *General Electric Mobile Radio Department. Circle 111 on Reader Service Card.*

● CONTROL SYSTEMS featuring FORTRAN IV are described in a four-page brochure MB3120. Hardware for the Prodac 2000 series computing control systems are described in bulletin DB-23-201. *Westinghouse Electric Corp. Circle 112 on Reader Service Card.*

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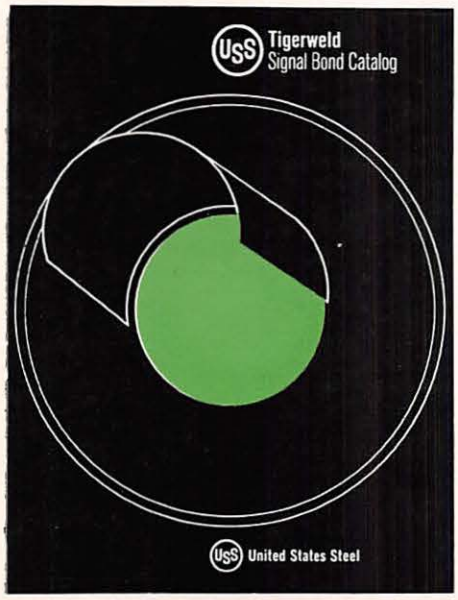

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